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OUR BETTER ORDERING AND PRESERVATION[1]

By Dr. ISAIAH BOWMAN

PRESIDENT OF THE JOHNS HOPKINS UNIVERSITY

THE title of my address is a phrase from one of the earliest documents of American social history, the compact made on board the *Mayflower* before she reached Plymouth harbor. Since the patent under which the company sailed from home was drawn for Virginia and not for New England, whither storms had deflected the ship, it was deemed necessary to have a form of government adapted to the new situation and to frame "laws for the general good"—to prevent a few asocial men in the company from imperiling the enterprise. Before they set foot on the new land of hope and liberty they drew up a document constraining and defining each man's liberty. It was the good of the whole they sought, which implied recognition of the harm that might result from the wayward course of the individual. To "combine ourselves together into a civil body politic, for our better ordering and preservation," was the first requirement. Whatever the new land was to give or to deny, the first problem was the choice of a social and moral order under which they were to live.

It is significant that the text of the compact is brief. They did not know what kind of land it was, whether rich or poor. The winter's privations were before them. They shared the land with unpredictable savages. They did not know how the members of the company would get on together. In short, they had to go forward from day to day, and meet problems as they arose. The important thing, after dedication of self-government to the general good, was *how to agree* on what to do, whatever it was that they would find it good to do. That is the core of the document. If laws were to be for the general good, men were to obey

[1] Dedication address, Natural Resources Building, Urbana, Illinois, November 15, 1940.

whatever should be agreed upon *by the company*. We recall this sound principle on an occasion devoted to conservation in 1940 because loose talk about individualism and free enterprise may have blinded us to the fact that there never was free enterprise in America except on the part of the trapper and hunter and then only when he went outside the bounds of settlement. Anything having to do with social living is not free but bound by "the general good," and it has been so from the far beginnings of settlement in America—in Virginia, at Plymouth, in Maryland and Georgia, and no less in Illinois as shown by the provisions for a popular assembly, judicial procedures and education, in the Ordinance for the Government of the Territory of the United States Northwest of the Ohio, confirmed by the Congress of 1789.

There is something so pervasive in the influence of the men who wrote the *Mayflower* compact as well as other early New England settlers and their descendants upon American intellectual and material development that it can not have been chance that won for their codes and systems such wide allegiance on the part of successive generations of westward-spreading settlements. The essence of their community ordering has had continuing significance: it is vital to our system of living to-day. If this be true, the recognition is especially useful at a time when we meet to look along the road ahead, when we try to see the present meaning of that "wise and continuing use" of our natural resources, as Theodore Roosevelt expressed the purpose of conservation.

Writing in 1858, John Gorham Palfrey in his "History of New England" well expressed the principle of the "better ordering and preservation" of the Plymouth Plantation. He said that the people of early New England formed "a distinct character by its own discipline, and was engaged at work within itself, on its own problems, through a century and a half." *At work within itself by its own discipline!* Other leaders, other emphases. More than two centuries after the landing at Plymouth John C. Calhoun was to plead, in his enthusiasm for internal improvements, "Let us conquer space." Whatever impedes the intercourse of the extremes with the center of the country at Washington, he argued weakens the Union. Social intercourse would be promoted by wider and swifter "commercial circulation" over extended roads and canals, the people would be bound together socially and politically, thus avoiding the estrangements that might otherwise follow our perilously rapid territorial growth. But what was it that he would bind together? Just people, communities? Back of his question lay a deeper one. Calhoun did not say what was going on in the communities that were to be so bound or how he would improve them. The question is all-important, for if we have not improved the people of a country we have not improved the country at all.

Settlement in America, Palfrey explains, meant not only the arrival of European colonists, "but the framing and establishing of that social system, under which, through successive generations, their descendants have been educated for the part which they have acted in the world." When the settlements of New England were at work within themselves they were framing a social system; that is to say, they were making a choice of values—they were accepting this and rejecting that. They were establishing something they had thought about, something that had been deliberately chosen by the community. They did not look to Education with a capital E to set everything straight, as some of our modern critics are inclined to do. What happened to a young man or woman after school years was also important. In Palfrey's phrase, successive generations of descendants were *educated under a social system* that had been framed and established (and we may add modified) for the general good. A largely unmixed group of communities of English origin, the New England settlements were able to maintain their identity unimpaired, to remain homogeneous and in a certain degree of seclusion from the rest of America, to develop a *character*, to choose values deliberately, to order and preserve that which they believed to be good.

A former Justice of the Supreme Court of the United States recently stated that the times called for a return to "morality," defined as that which men and women through long discussion, observation and agreement about experience of social living have found to be good and have built into community character. This reads like a gloss on John Morley's conclusion ("On Compromise," 21–22), "Moral principles, when they are true, are at bottom only registered generalisations from experience." Vital to the general good is a sense of morality, felt, inculcated and built into a democratic society. It is fatuous, continues Morley, to believe that "a government may depress the energy, the self-reliance, the public spirit of its citizens, and yet be able to count on these qualities whenever the government itself may have broken down—." To flout experience and deny the possibility of ensuing evil condemns any system, however noble its humanitarian pretensions.

Valuable as Morley's commentary may be, our "better ordering and preservation" require an extension of his definition of public morality if applied to our times and problems. Finding ourselves confronted with problems hitherto considered insoluble, we are obliged to experiment. Our resources are not what they once were, our population has been thrown in upon itself, the different purposes and values of land have already overlapped, we have to make many more choices be-

tween two goods and not merely a choice between good and bad. A recent report upon the national wealth of Great Britain, made for the purposes of national defense, has shown that while the land is worth £620,000,000, the buildings are worth £4,600,000,000, or seven times as much. Building or destroying a house or planting or wasting an acre now represents a choice by more than the individual and the choice must be made for the general good. From the standpoint of engineering, England is now fully occupied: the whole of it is an industrial plant. Her cities can not grow much more without reaching the limit of possible service in water supply, thus getting in the way of each other. The food demand has long since outrun the domestic supply, and naval strength and food are tied together inexorably. A battleship is a machine shop supported by a vast number of other intricately related machine shops, mines, aptitudes and skills. Government in such a land is necessarily a business, a whole people's business, and much of it is new business and new experience as well as new or revised morality.

In this country we are following the same road at a slower pace. If we greatly extend our foreign commerce, and if our population continues to increase and, what is more important, to require a yet higher standard of living, we shall find ourselves greatly multiplying the number of choices we have to make between one kind of ordering and another. We can not just grow and pay no attention to the social strains of growth, as if increase of size were itself a virtue. As a matter of fact, as a thing gets beyond a certain scale or size, it gradually ceases to be the original thing and becomes something different. In a motor-car collision at ten miles an hour you may be hurt; at fifty miles an hour you are not hurt five times as severely, you are dead! The general good requires us to adapt our choices of laws to changes in social aims and character that growth inevitably brings.

It is clear from the events of the past twenty years that the time has come when America must take a good look at itself in the mirror of experience. Filled with people, some of the land that we have used or destroyed or wastefully exploited has begun to dehumanize some of its occupants. We have reached the point where civilization is a disease, not merely for conquered savages that we "protect" but for those among us who live on wasted inheritances of soil, minerals, blood. When civilization piles up evil features it is time to refer to "the general good." It is time to work harder within ourselves under our own discipline, as Palfrey phrased it. It is time to look at the morality of things-as-they-are. Woodrow Wilson saw that time coming: "Presently there will come a time when America . . . will be obliged to pull herself together, adopt a new regimen of life, husband her resources, concentrate her strength, trust her best, not her average members."

This inescapable thought runs through American history. It is not a novelty of to-day or a careless improvisation to meet a sudden emergency. In this State of Illinois Abraham Lincoln began his career, made his nationally known House Divided speech, set the purposes of his life. I may appropriately quote him in reference to the distinctive purpose of American society. In his first annual message delivered in December, 1861, he defined the war aims of the Union. He said it is "a struggle for maintaining in the world that form and substance of government whose leading object is to elevate the condition of men—to lift artificial weights from all shoulders; to clear the paths of laudable pursuit for all; to afford all an unfettered start, and a fair chance in the race of life."

It is in the mood of our times to regard the choice of social values, or agreement about our "regimen of life," as matters political, as symbols of unrest, as a desire for revolutionary change. Only the historically blind and deaf could so regard them. Each age has its crisis that lifts men and leads to the higher development of intellectual and spiritual powers: "depth and passion and resource are needed for stormy times," and the times help exhibit if they do not make the qualities. Out of crisis and clash of interests come the new choices of values and things to be conserved, and equally of values and things that must go by the board. The "Rolls of Parliament" for fourteenth century England are full of petitions submitted by merchants, for the suppression of weirs, locks and mills, that "thwarted" the streams and were detrimental to "the passage of ships and boats on the great rivers of England." Roads were bad and even rich merchants, like common pedlars, had to travel over muddy roads. Travel by water, if possible, was a safer and more comfortable way of reaching the numerous fairs where itinerant merchants did their most important business. Without telegraph or railway post, travel in those times was much less for pleasure than from necessity. Whatever blocked the streams blocked commerce. Parliament had to choose between the mill and the ship, between the miller and the merchant. Now the choice was one way, now another.

Principles grew out of this experience and they survive as active forces all over America as in England, in your State of Illinois, in my State of Maryland, as survivals of earlier centuries of English experience. Even five hundred years ago there could not be free enterprise except within the limits of compromise of conflicting claims with the general good in view. Those who challenged authority, because of a right denied, almost always won out in the end, whatever their personal fate. Over five hundred years ago John

Ball, a priest, was drawn, hanged, beheaded and quartered, because he made too much fuss about the general good. He traveled widely and preached. What he said seems mild to-day. One of his surviving lines is, "They dwell in fayre houses, and we have the pain and traveyle, rayne and wynde in the feldes."

There is rising in this country a belief that loyalty can be made a living principle only if we agree that the first mortgage upon our future talent and time, after national defense, is laid by the problem of unemployment. This belief will be pressed home by our preparations for national defense. You can not ask a hungry man to get excited about saving the country. He will ask, Whose country? Proposition number one in our national policy should be that no one shall go hungry, and this means that no one who desires to work shall be left unemployed. The "general good" invites each man to try his talents, and develop his powers through education, provided not at his expense but at the expense of the taxpayer. The community says, "Let's see what you can do and what you are worth. After that you must take your chances and do what your aptitudes indicate that you can do in unhandicapped competition with the rest." When that has been done, liberty becomes in such a man, or should become, a thing alive and substantial. We can then expect that a man's faith and confidence become joined to his sense of liberty. Steep and precarious as the road to this high level may be, we have no choice but to take it. The Promised Land is widely diffused prosperity. The opportunities and risks must be matched by courage. We can speak of the remedial future in no other terms.

And we can not deal with the future at all unless we employ the imagination: "a faultless judgment on the circumstances of the present is not enough." It has been said that a practical man is a man who practises the blunders of his predecessors, but it is fairer to say, with Buchan, that a profound practical intelligence is a rarer thing than seminal idealism. Concocting things in a study may be sheer waste unless joined with experience. Practical men and politicians have this in common that they are able "to devote extraordinary abilities to the propagation of commonplace views. . . . Their function is not to carry flame but weight . . ."

I have been quoting from the late H. A. L. Fisher, warden of New College, Oxford, historian and man of wide acquaintance and experience. Hear his conclusion of the matter:

> The great statesmen of the world have had a very concrete sense of human realities. They have not lived in a world of abstractions, but have always kept before them the vision of men and women and children, for the most part poor and struggling, and, therefore, quick to feel the inequalities and imperfections of Government. The stuff of which politics is made is in reality very simple—bread, coal, clothing, meat, houses, and land. To help improve the common lot—this is the ambition which makes, and will continue to make, the biggest and most generous men in any society desire to take up politics.[2]

In the examples that I have cited, in the moralities concerned with the general good, in my remarks about the politician and the practical man in relation to our remedial future, I have been trying to approach the detailed questions of conservation in the light of *principle*. I have referred to the hungry man and the unemployed man for the same reason. It is no good at all to study the gypsum and lead deposits of the State of Illinois, or look into the conservation of oil and gas deposits, or lower the rate of soil erosion, or improve the health of your people, or reduce the damage of insect pests, and of fruit and tree diseases, unless you look at these things from the standpoint of the better ordering and preservation of something that you have deliberately chosen which includes all the other aims and objects of your civilization. It has been said that we can afford to neglect politics, which ought to mean the general good, because we are so affluent. Sheltered by size and distance from lightning attack by external foes, it has seemed as if we could afford to be an "intermittent democracy." We could work at it when we felt like it. We looked to others to develop or choose the great ideas, forgetting that whatever we have gained of distinctive American excellence in the political field has grown out of self-discipline, awareness of the common good, an agreed method of reaching agreement, the development of community *character*, the better ordering of our affairs. There is nothing we can say or do about conservation that is not embraced in this scheme of nation-building.

I emphasize the careful location of conservation in the American scheme of things because of the great number of techniques that are applicable to conservation and among which it is easy to get lost, ignoring compass and route. Conservation of our natural resources now includes all resources; it takes in the land beneath a man, the weather above him and the man himself. About all these things Charles A. Beard has remarked that "Nature presents no problems. We ourselves raise all of them." The other day I picked up a geography text used in the schools just 100 years ago. I looked up the section on Illinois and found it described as a land "of inexhaustible fertility" and the proof thereof was that crops had not diminished in volume after a century without fertilizer. The settlements of Illinois two hundred years ago were too small in number to prove anything so fundamental as that, and we have now come to the point where the care of the soil is just as important as what you are to eat at

[2] "Pages from the Past," 1939, p. 215.

the next meal because land and food and health are now very closely tied together.

There is something apparently so simple and easy in the "waste not, want not" formula of conservation that the essence of the thing may be overlooked entirely. That essence for society is that the general good shall rule the mode of exploitation. It is not a problem in waste merely. The essence of a scientific conservation program is that we do not yet know fully what we waste, or why we waste, or how serious that waste may be unless we first find the law of waste for every wasted thing. We search for basic causes, on the sound principle that after we have related cause and effect we *may* be able to find the cure for undesirable effects. Nature did not ask that the prairie sod be broken, the woodlands of the valley floors cut off, the streams polluted. Men began doing these things in complete ignorance of the result now before us or without any curiosity about any "law of waste," and without realizing how easy it is to destroy a natural balance of forces, which, once destroyed, changes the land itself as human habitation, and changes the degree of welfare. Nor could men have foreseen fully the day of conflicting interests when, with population swarming everywhere, city health services widening their inexorable demands, and standard of living becoming more and more a matter of social responsibility, compromises among interests had to be effected on an ever-widening scale. We had to learn all over again how nature works at the same time that we had to learn how to keep our fundamental American aims—America as a land of opportunity, reasonable freedom, self-discipline, evolving moral system, never forgetting the poor and struggling and their preoccupation with those simple realities, "bread, coal, clothing, meat, houses, and land."

More than 100 years ago Disraeli was hammering at the truth that supreme control over mechanical power was paralleled by no proportionate advance in moral civilization. There was only a hurry-scurry of money-making, men-making, machine-making, as he put it. England had altogether outgrown not the spirit but the organization of her institutions. When a new race of men demanded general or popular education the ministry fell into a panic! What would he say of that continued lack of parellelism? Emerson in a later decade expressed anxiety about the human effects of a machine civilization. Carlyle was one of the most brilliant of the literary group that saw no social progress in mere multiplication of machines and money. Macaulay, on the other hand, found inspiration in material expansion and its cultural effects. Our recent excitement about such effects is an old emotion. The dish has been served again and again. What followed the peace that closed the Napoleonic Wars also followed the World War and Versailles—commercial dislocation, wide social demands upon government for jobs and higher standards of living, self-criticism, social education and social discipline, individual good and general good brought into harmony if possible. The advocates of routine have no place in a time like that! The same power that goes into discovery and machine invention must go into social objectives, their definition and purpose. It must be as important to think about the welfare of the people of the corn belt as to think about the convenience of a self-starter. It must become more praiseworthy to think about the protection of men in a shop than to think about the perfection of the transient and material things which they produce. The conservation of our natural resources, meaning the wise and continuing use of resources, is a problem in social ethics.

Scientific research has made almost magical progress, but many are the problems yet to be solved by science. The men at work in the new building which we have met to dedicate will take an active part in their solution, have no doubt of that. New facts, new techniques, new principles will come out of that work. These things we may take for granted. What we can not take for granted is the attitude of the commonwealth of Illinois toward the results of that scientific work. So if I talk but little about your water-supply upon which, 34 years ago, I spent an interesting summer; if I touch lightly upon forests and soils, it is because their proper study and disposition depend on a far more fundamental thing—the social system of the state that supplies the framework for all scientific and educational enterprise, affects the position of that enterprise.

Let us take highways as a useful example of the conservation of energy and human life, almost as important to-day as forests and power installations. When we first began to drive motor-cars the morals of the road were amazingly low. They fell still lower when practically every one had a car. We often said when we met a bad driver, "What can you expect when every one drives a car, the imbecile along with the intelligent?" Now we can say that experience, education, improved mechanics, better roads from the standpoint of the limits of human skill, eyesight and attention, have built a road ethic far ahead of what we had originally. With center lanes extended and a stricter control of drinking drivers the present shameful accident record will be improved. Every one of intelligence has found out that warning signs are put up for *his* safety. "That man is free who is conscious of himself as the author of the law which he obeys" (T. H. Green).

Soil conservation is taking the same course but more rapidly. The demonstration is right under your eye in the field. When it comes to forest control we are still far below acceptable standards. The gap is so wide

between the forested watershed above and the farm below that cause and effect are less obvious. The technical aspects of control are now well known. It is the social ethic that lags behind. Partly, this is because the general good grows yearly more complex and difficult to see clearly or to deal with simply. The political channels are crowded with issues from bank to bank. Time is wasted on postmasterships that should be spent in quickening the national conscience about the waste of things we shall never again recover, like that forty-acre farm that goes down the Mississippi every minute.

A social system devised for the general good, "for our better ordering and preservation," must be built upon a moral conviction sustained by self-discipline in individuals and in the nation. Breasted has sought the beginnings of moral experience in the life of the Egyptians and attaches significance to the early appearance of *Maat* (right). "A man's virtue is his monument" reads the autobiography of an Egyptian nobleman inscribed on an ancient stone tablet. Another runs, "I was one who heard (legal) cases according to the facts without showing partiality." Gradually *Maat* passed into a method of moral guidance and control of human affairs, and especially public affairs. Orderly administration became suffused with moral conviction. For a thousand years, concludes Breasted, organized government gave Egyptians of the Old Kingdom a majestic picture of the actual operation and beneficence of *right*.

The dream of democracy is wise self-control and self-dynamic through education, through the exploration of "the edge of the possibilities" by individual initiative, through a government inspired and informed by the general good, by *Maat* or right. The goal is a controlling majority doing the right thing as a result of intelligent forces at work within, rather than by arbitrary force imposed from without. Conservation is therefore an educational job in large part. But I would warn you that the educational task is partly an emotional task as well as a task in reason and persuasion. Some one must be on fire about it. Feeling is a part of the job of the men who occupy this building. Creation is the product of passion.

You have both noble and ignoble examples to point the moral of your effort. Whether or not men were once able to walk from Egypt to Morocco in the shade, the changes in North Africa have in the main been degradational since two millenniums ago. One of the earliest vernacular names of Ireland was Fiodha Inis, or the Woody Island. The name of an ancient tribe inhabiting the southern coast of the County of Cork was Vodii, or dwellers in a woody country. Many of the old names of hill and plain are words implying forests, groves or trees. In describing Ireland in the *Cantos of Mutability,* Spenser speaks of the "woods and forests which therein abound." A century afterward the author of a Chorographical Description of the County of Meath complains of the want of timber of bulk "wherewith it was anciently well stored," and recommends to Parliament the making of provision for planting all sorts of forest trees. Only a few years ago we rested our case for soil conservation upon general examples like these until methodical enquiry startlingly disclosed our own impending plight. The soil profile in many cases showed good soil in a thin layer-remnant only. Crops were still barely possible. A few years more and what looked like uneroded country would be skinned of its surface layer of fertility and tilth. The Tennessee Valley is such a marginal area. Caught between political fires, challenged from the standpoint of widening social control by the federal government, the fundamental truth that the soils of much of the Valley were on the brink of destruction has been obscured. How to save and improve them might be disputed. There could be no dispute about the heroic scale of required measures.

There is a saying in England that the ships and therefore the victory of Nelson was made possible by the tree-planting of John Evelyn in the 17th century. England's timber was thinning at an alarming rate when a man in a passion about it made himself England's primate in forestry. But for his work more than a hundred years before Nelson there could have been no Nelson. This may be pushing the argument too far, but it is not pushing the moral too far.

The day will surely come when similar instances will be cited in America, when niches of fame, well-earned on behalf of the general good, will be filled with the names of those who have fed migratory birds, dramatized thinning soil horizons in terms of human want and decline, taken steps to save from spoliation the diminishing stock of whales, and created wilderness shrines for wildlife, but more importantly for man, as an example and a warning and as a lesson in social conscience.

I spend a part of each summer near Wolfeboro, New Hampshire, and during the past summer I reread the town history. On one page the sole record of a citizen is confined to the statement that he made a watering trough that lasted for 150 years. It set me to wondering whether I had made anything that would last that long, and how many other men had done so. What are the memorials of our present effort, of the worth of you and me? What permanent things have we created? Here in America we can yet have it said in times to come that we have made the greatest thing in the world. We have made America a place where the free will of 130,000,000 people, trained to think in terms of the general good, have found a permanent form of self-expression through self-discipline; a place where men were not "most boastful of their intelli-

gence but proudest of their wealth," but rather a place where a moral conscience grew amongst a whole people, where a sense of the majesty of *Maat* or right became pervasive.

It was a professor in another state university in this region who said that institutions have to be created as systematic reminders of good ideas. Conservation is not only a good idea; without it there will cease to be an America as we know it. When and if that time comes it will not be the Mississippi that will be to blame or a change of climate or European wars. It will be man—the men and women of America—you and I—who created the problems where once there was bounty and balance in nature. The structure that we have met to dedicate symbolizes an idea, a morality, a common good, right. Though time crumble its walls, if the idea of common good survives, the purpose of the building will have been fulfilled. Backed by a passion for human welfare, its staff will reach out into every part of the state to earn dividends upon the public investment which it represents.

According to Livy it was an ancient Roman custom to enclose any place that had been struck by lightning and keep it inviolate ever after. In such a place a stone was buried to represent the lightning. The enclosure was called a "puteal" and it was sacred. This building may be called a modern form of puteal. It represents interest in the forces of nature, forces unbalanced by man and now striking back with lightning effect. It is a place inviolate from those who talk freedom and are silent about the common good. Our puteal may last like that watering trough at Wolfeboro for 150 years, or like the sense of *Maat* in Egypt for a thousand years, according to the will and the conscience and the intelligence of the people of Illinois at work upon their own problems and, like the men of the Plymouth Plantation, forever intent upon the changing question of their better ordering and preservation.

STATUS OF BIO-ASSAY OF THE DIGITALIS GROUP[1]

By HARRY GOLD, M.D., and McKEEN CATTELL, M.D.
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THE bio-assay of digitalis is made necessary by the fact that pure principles are not generally available, and most of the practice is confined to the use of crude material or mixtures of glucosides. There are no satisfactory chemical methods for their estimation. Numerous methods have been suggested for the assay of digitalis, embracing a wide variety of animals and techniques.

The U. S. Pharmacopeia has taken a hand in the problem with the view of providing digitalis of uniform potency. Every specimen labeled U.S.P. digitalis is compared with a standard digitalis powder on a qualified batch of frogs. All digitalis labeled U.S.P. is supposedly of the same strength within the limits specified, namely, $\pm$ 20 per cent.

Table 1 shows how variable digitalis was before the pharmacopeia described a method of assay. These data were used in 1907 by Edmunds[2] in support of his recommendation for the inclusion of the frog method into the pharmacopeia. He assembled a number of preparations of digitalis and assayed them by a frog method. He found the strongest about three times as potent as the weakest. Since then a fairly large literature has accumulated on the subject of digitalis assay, and statistical refinements have been introduced into the treatment of assay data for the purpose of improving the accuracy of the methods.[3, 4]

TABLE 1

TINCTURES OF DIGITALIS ASSAYED BY THE FROG METHOD IN 1907 BY EDMUNDS

No.	Toxic dose (cc)	Origin of plant
1	.08	From German leaves.
2	.11	From English leaves.
3	.12	From leaves obtained from manufacturer of tincture No. 5.
4	.13	
5	.15	Physiologically assayed.
6	.16	From physiologically assayed leaves.
7	.175	Physiologically assayed.
8	.18	
9	.18	From German leaves.
10	.19	
11	.20	From English leaves.
12	.21	
13	.26	"German tincture."
14	.27	
15	.28	
16	.29	From English leaves.

About six months ago we assembled a number of the outstanding brands of tincture of digitalis, labeled U.S.P., supposedly of similar potencies. We assayed them by the cat method,[5] and the results are presented

[1] Based on an address given before the Cornell University Medical College Research Society, November 7, 1940. Part of the material represents work carried out at the Beth Israel Hospital, and the Hospital for Joint Diseases, New York City, in collaboration with Dr. Nathaniel T. Kwit and Dr. Milton Kramer, later to be published *in extenso*.

[2] C. W. Edmunds, *Jour. Am. Med Asn.*, 48: 1744, May 25, 1907.

[3] C. W. Chapman and C. A. Morrell, *Jour. Pharmacol. and Exp. Therap.*, 46: 229, October, 1932.

[4] L. C. Miller, C. I. Bliss and H. A. Braun, *Jour. Am. Pharm. Asn.*, 28: 644, October, 1939.

[5] The technique employed in this laboratory involves intravenous injection, either continuously or in equal fractions at 5-minute intervals, until death in an average period of between 60 and 90 minutes in the cat under very light ether anesthesia.

in Table 2. The strongest tincture is nearly three times as potent as the weakest.

TABLE 2
POTENCY OF TINCTURES OF DIGITALIS (U.S.P. XI)

	Specimen	Cat unit potency cc of tincture
1	John Wyeth	0.35
2a	Parke Davis	0.36
2b	Parke Davis	0.46
3	Squibb	0.58
4a	Digitol (Mulford)	0.58
4b	Digitol (Mulford)	0.86
5	Lilly	0.60
6	"Tr. Digitalis U.S.P. XI"	0.96

It seems, therefore, that we are in need, not merely of improvement in the method of assay, but that we are in need of a method of assay.

Various complaints have been lodged against the animal assay methods. One favorite objection is that they measure the toxic action of digitalis glucosides, not a therapeutic action: systolic standstill of the frog's heart, or fibrillation of the ventricles in the cat. The therapeutic action is a difficult matter to get at directly, representing, as it does, the increased force of the heart's contraction.

The search for a therapeutic end-point for the assay of digitalis in animals doesn't seem to be very important, however, because the therapeutic and toxic effects of digitalis are due to the same action, and there is no good evidence for a significant difference in the ratio of the doses exerting toxic and therapeutic actions.

The literature on this matter is limited, and most of it is not convincing. The experiments of Visscher and his collaborators[6] have aroused a good deal of interest. They concluded that digilanid C has 30 times as great a ratio of the toxic to the therapeutic dose as digilanid B. To obtain this figure, they related the concentration in the heart-lung preparation of a dog to the intravenous fatal dose for the cat. Without going into an evaluation of this method, suffice it to state that there are reasons for believing that for a valid ratio of toxic to therapeutic dose, it is necessary to compare these doses in the same test object.[7]

We studied this problem[7a] in the laboratory by means of the papillary muscle technique[8] which was described before this society last year. You may recall that when the papillary muscle of the cat's ventricle is made to record its tension developed during systole by means of an isometric lever, we obtain a record such as this (Fig. 1). When the muscle begins to fail under the unfavorable circumstances of the environment, a digitalis glucoside restores the systolic tension. After a time the muscle begins to fail again, and we

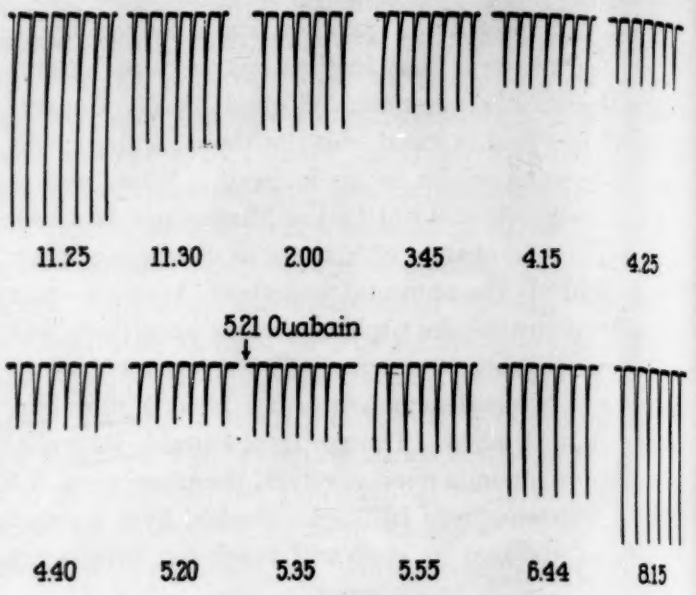

FIG. 1

found that the length of time elapsing before the muscle fails with toxic doses is dependent on the potency of the preparation. The next chart (Fig. 2)

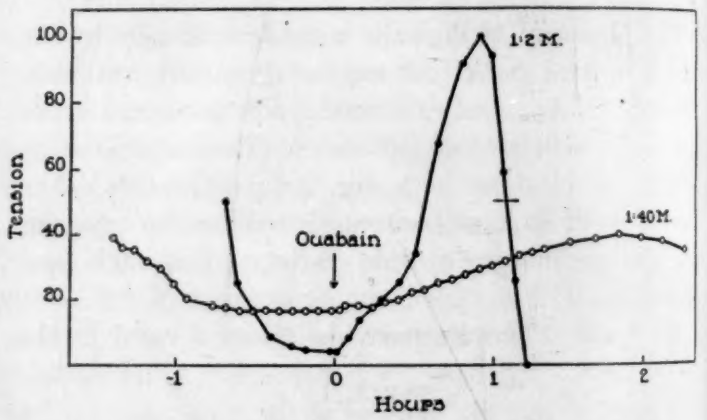

FIG. 2

shows the appearance of the record when one compares a 1:40 million solution of ouabain with a 1:2 million solution. You will note that the time from the application of the drug to the depression to half-tension is much shorter with the stronger solutions. Using this papillary muscle technique, we related the minimal dose which causes a rise in systolic tension, which we call the therapeutic dose, to the dose which causes the toxic effect. We compared a variety of preparations in this way and found that ouabain, digitoxin-like materials,[9] and lanatoside A, B and C (Sandoz), widely different digitalis glucosides, show no significant differences in the ratio of the toxic to the therapeutic dose.

An attempt was made to secure some information about this ratio from experiments on humans by determining the incidence of poisoning when a full thera-

[6] G. K. Moe and M. B. Visscher, *Jour. Pharmacol. and Exp. Therap.*, 64: 65, September, 1938.

[7] McK. Cattell and H. Gold, *Jour. Pharmacol. and Exp. Therap.*, 66: 7, May, 1939.

[7a] McK. Cattell and H. Gold, *Jour. Pharmacol. and Exp. Therap.*, 71: 114, February, 1941.

[8] McK. Cattell and H. Gold, *Jour. Pharmacol. and Exp. Therap.*, 62: 116, January, 1938.

[9] The preparations of digitoxin-like materials we used were Digitaline Nativelle and Digitoxin (Merck).

peutic dose is given, and comparing that with the incidence of poisoning when the full therapeutic dose is doubled. In this way we compared digitalis leaf with the digitaline and with lanatoside C. Table 3 shows

TABLE 3

RATIO OF TOXIC TO THERAPEUTIC DOSE IN MAN

Preparation	Number of full therapeutic doses	Number of cases	Incidence of toxicity (per cent.)
Digitalis	1	82	3.7
	2	125	38.4
Digitaline (Nativelle)	1	24	8.3
	2	13	46.0
Lanatoside C	1	26	7.6
	2	16	50.0

the results. The ratios are of the same general order for the three preparations. Nearly half of the patients develop toxic symptoms when the therapeutic dose is doubled.

Therapeutic or toxic end-points, therefore, serve equally satisfactorily for assay purposes.

The real problem seems to be that when two preparations of digitalis are compared by different methods or in different animals, different answers are obtained. In Table 4 there are some illustrations of this. Here

TABLE 4

RELATIVE POTENCY OF DIGITALINE (NATIVELLE) AND LANATOSIDE C BY VARIOUS METHODS

Test method	Digitaline (mgm)	Lanatoside C (mgm)
Cat assay	1	0.7
Papillary muscle	1	10
Oral therapeutic (man)	1	12
Intravenous therapeutic (man)	1	1.5

are two glucosides of digitalis, the potencies of which are compared by different methods. When the digitaline or digitoxin (Merck) and lanatoside C are injected intravenously into cats until death occurs by the method of the cat assay, lanatoside C is found to be a little stronger than the others. However, when one compares these preparations on the isolated papillary muscle, one obtains a very different answer, and in the reverse direction. Instead of lanatoside being stronger than the digitoxin-like materials, it is now found to be 1/10 as strong. In the cat method of assay the whole body is exposed to the digitalis glucoside, whereas in the papillary muscle technique only the heart muscle is exposed to it. The question arises whether the reversal in order of potency may not be due to differences in the fixation of the drugs by other body tissues, or possibly chemical alteration by the tissues. When one compares digitaline and lanatoside C by intravenous administration in man, they are found to be nearly of the same potency, but the digitaline is about 12 times as strong as lanatoside C by oral administration. It is clear that one of the chief factors in this difference is the degree of absorption from the gastrointestinal tract.

All this, by way of illustration of the fact that different methods of assay yield different results with respect to the relative potencies of two preparations of digitalis glucosides. The question then arises, which of the known methods yields the correct answer? Which gives results valid for humans?

The two methods with which most of the work has been done are the cat method of Hatcher and Brody, and the one-hour frog method of the U. S. Pharmacopeia.

When the tincture of digitalis ages it grows weaker by the frog method, but its potency changes little by the cat method.[9a, 10] The explanation may lie partly in the fact that the frog method involves absorption from the lymph sac, whereas the cat method involves no absorption, since here the drug is injected directly into the circulation.

Recently the government seized a tincture of digitalis because they found it only about ½ as potent as U.S.P. digitalis. But when we tested this tincture by the cat method, we found it to possess the expected potency of a U.S.P. tincture, namely, 0.67 cc per cat unit. This tincture also proved to have full potency in man. A similar discrepancy in the results by the cat and frog methods was obtained with the present specimen of digitalis which has proved entirely satisfactory in the 60 member clinics of the New York Heart Association. By the frog method, 2.6 mgm of this digitalis equals 1 mgm of U.S.P. reference powder, whereas by the cat method only 1.6 mgm of this digitalis equals 1 mgm of the reference powder.

Each of the two methods has its own group of supporters, but there have been no satisfactory experiments in humans to show which gives results that are valid for man. We have made some studies bearing on this problem. In these it is essential to compare the different specimens in the same individual and to select such doses as fall in the critical range of sensitivity for the given individual.

We have made comparisons using as criteria of effects the ventricular rate changes in patients with auricular fibrillation and T-wave changes in patients with regular sinus rhythm. Both methods give the same answer. Both reveal the full therapeutic action of digitalis.[10a]

Fig. 3 is an example of the type of experiment made in a comparison of two preparations. The patient entered the hospital with auricular fibrillation and a

[9a] F. Wokes, *Quart. Jour. Pharm. and Pharmacol.*, 2: 48, 1929.

[10] C. C. Haskell, *Jour. Am. Pharm. Asn.*, 14: 492, June, 1925.

[10a] H. Gold and McK. Cattell, *Arch. Int. Med.*, 65: 263, Feb., 1940.

rapid ventricular rate. He was put to bed and the routine examinations necessary for a complete diagnosis were made, including urine and blood examinations, electrocardiograms and x-rays. While the patient lay quietly in bed, a one-minute apex count was made with the stethoscope at least three times daily, during the control period of seven days or longer. The average rate for the day is represented by one point on the curve. The full dose of digitalis was given at one time. The apex count was then made in the same manner every hour throughout the day. In the succeeding days, the record was obtained in the same way as in the control period. When the rate returned to a level approximately that of the control, as was the case in two or three weeks, the second specimen of digitalis was given in the same way, and a similar record was

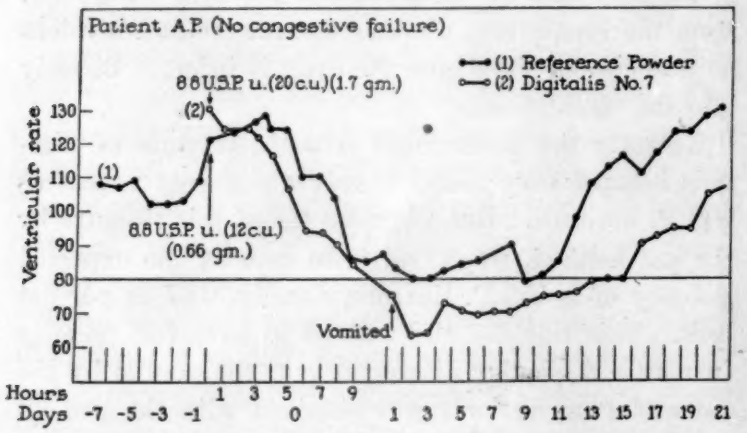

FIG. 3

made. The sensitiveness of the method was determined in several experiments in which different doses of the same preparation were given. The order in which the different doses and different preparations were given was varied so as to be certain that the effect of the second dose did not represent the summation of effects. The results in Fig. 3, which are typical of a group of experiments, show that the one-hour frog method of the U. S. Pharmacopeia is misleading. A dose of 8.8 U.S.P. units of one preparation of digitalis leaf produced satisfactory digitalization, while the same number of U.S.P. units of another preparation produced a lower rate as well as symptoms of poisoning in the same person. When the foregoing doses of the two preparations are expressed in cat units, the one which produced the smaller effects represents only 12 cat units, whereas the one which produced poisoning represents 20 cat units.

It appears from these results that the cat method may be better than the frog method for digitalis in that the intensity of the effects seems to follow in a more direct relationship to the number of cat units. However, there is evidence that the cat method, when applied to purified glucosides, is also misleading. Fig. 4 shows a comparison of the effects of cat units of the digitaline with cat units of digitalis by oral administration. Note that 3 cat units of the purified material produces the same effects as 20 cat units of digitalis. It would prove disastrous to give a patient the same

Comparative Effects of Cat Units of Digitaline Nativelle and Digitalis by Oral Administration

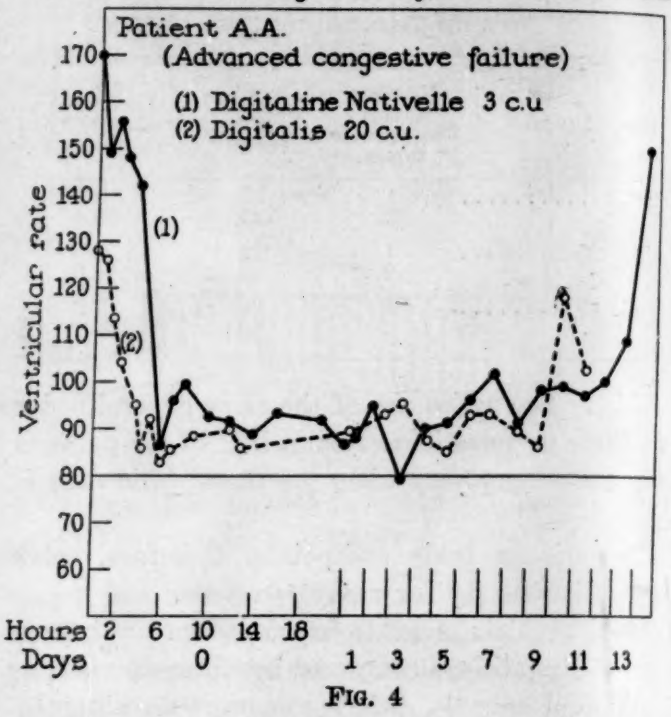

FIG. 4

number of cat units of digitoxin or digitaline as of digitalis.

Digitoxin-like materials are well absorbed,[11, 12] whereas in all probability only the digitoxin-like frac-

Comparative Effects of Digitaline Nativelle by Oral and Intravenous Administration

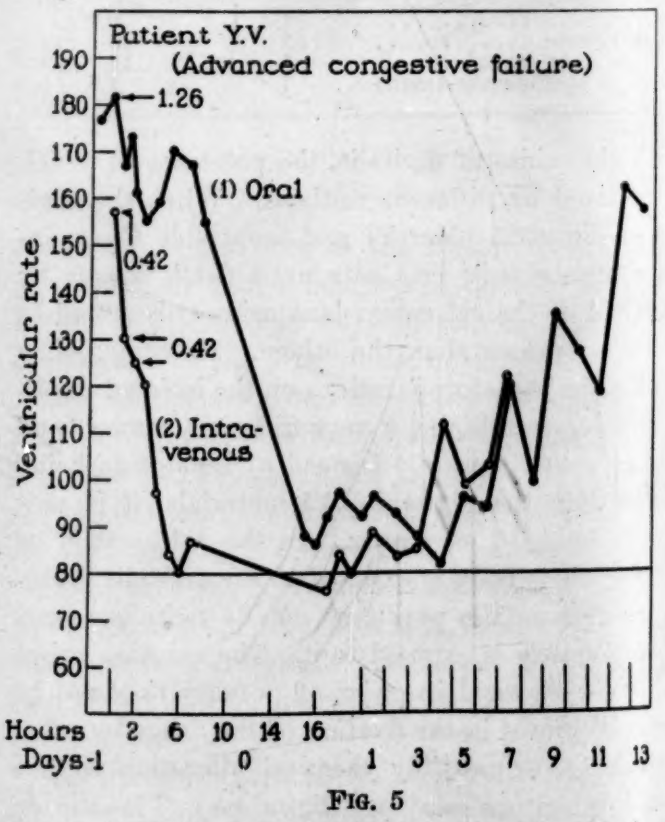

FIG. 5

[11] R. A. Hatcher, *Jour. Am. Med. Asn.*, 75: 460, August, 1920.

[12] C. Eggleston, *Jour. Am. Med. Asn.*, 75: 463, August, 1920.

tion in digitalis is absorbed under ordinary conditions, representing only a portion of the activity of digitalis. Thus a difference in absorption may explain the fact that a cat unit of the purified material which we used is about seven times as potent in man by mouth as a cat unit of digitalis. Fig. 5 shows that the dose (1.26 mgm) of digitoxin-like material by intravenous injection is the same as the dose by oral administration. In the case of digitalis, there is a wide spread between the dose by intravenous injection and by oral administration.

Differences in absorption, however, are not the only factors that bring the cat method into question. Several years ago Wyckoff and Goldring[13] made a study at Bellevue Hospital on patients with auricular fibrillation. They gave 0.1 mgm of ouabain intravenously every half hour and found that by the time 1 mgm was given, full effects had developed. In some of our recent experiments with the digitaline we found that the full dose of this material when given by intravenous injection is also between 1 and 1.26 mgm (see Fig. 5). The milligram of ouabain, however, represents 10 cat units, whereas the 1.26 mgm of the digitaline represents only 3 cat units. Since they were both given intravenously, absorption can not be responsible for the difference. The phenomenon must be due to a difference in the way in which the cat and man utilize the two glucosides.

The indications are that neither the frog nor the cat method overcomes all the obstacles to uniformity among digitalis preparations. From the practical standpoint what we need to know is the potency of digitalis preparations in man.

The foregoing observations indicate that the final evaluation of the potency of a preparation of digitalis must be based on determinations in man. We have made experiments[14, 15] which indicate that digitalis can be adequately assayed on humans. The T-wave changes of the electrocardiogram run parallel with the therapeutic actions of the drug and in suitable individuals, with or without heart disease, differences as small as 30 per cent. in the dosage of digitalis can be detected by unequivocal changes.

A more satisfactory solution is the use of purified digitalis glucosides which do not require bio-assay. It appears that there are digitalis glucosides which are well absorbed from the gastrointestinal tract and which can be extracted with reasonable uniformity.

[13] J. Wyckoff and W. Goldring, *Arch. Int. Med.*, 39: 488, April, 1927.

[14] H. Gold, N. T. Kwit and McK. Cattell, *Jour. Pharmacol. and Exp. Therap.*, 69: 177, July, 1940.

[15] N. T. Kwit, H. Gold and McK. Cattell, *Jour. Pharmacol. and Exp. Therap.*, 70: 254, November, 1940.

OBITUARY

FRANK CRAIG JORDAN

THE tragedy which cost the lives of Dr. Frank C. Jordan and his wife, Harriet Roy Jordan, shocked an unusually wide circle of friends and acquaintances.

Frank Craig Jordan was born at Cordova, Ill., on September 24, 1865; the son of John Henry and Louisiana Craig Jordan. Marietta College granted him the following degrees: B.Ph. in 1889; M.A. in 1892, and the honorary degree Sc.D. in 1929. In 1914 the University of Chicago granted him the earned degree Ph.D. His thesis, "The Color Changes of Certain Variable Stars of Short Period," is still an important document for all who are interested in these stars.

Following a number of years spent as instructor in astronomy and mathematics, he received a fellowship at Yerkes Observatory in 1905. He joined the staff of the Allegheny Observatory in 1908 where he was professor of astronomy in the University of Pittsburgh, assistant director, and since 1930, director.

Dr. Jordan's scientific work was divided between radial velocities of early type stars and the photometry of short period variable stars. Fifteen major articles dealing with stellar spectra, including eleven orbits, are found in the Publications of the Allegheny Observatory. One volume of these publications is devoted entirely to Jordan's observations and light curves of twenty-nine Cepheid variables and sixteen eclipsing variables. A number of light curves of additional variables await publication; for still other stars the data are not sufficient to permit the derivation of definitive light curves. These data will be made available to astronomers in a memorial volume.

Dr. Jordan had a number of interests. He was a faithful worker in his church and other community activities. Until recently he engaged in such athletics as swimming and tennis; more recently in golf; he played the organ with fervor and took great delight in music. But of all his interests he found the greatest enjoyment in observing with the telescope, in which occupation none excelled him either in enthusiasm or expertness. In the first decade of the work of the Thaw Refractor the exposures were short and the time required to change from one object to another was of importance. In this period 35,000 plates were secured, 12,000 by Jordan. On the basis of the average of other observers his share would have been 9,000. His great number of plates was not due so much to the enthusiasm with which he watched for breaks in the clouds as to the remarkable efficiency of his unhurried speed.

The American Association for the Advancement of

Science, the American Astronomical Society (treasurer since 1932), the International Astronomical Union, Phi Beta Kappa, Sigma Xi (charter member of the Pittsburgh chapter), Pittsburgh Physical Society, Amateur Astronomers Association, Academy of Arts and Sciences and other local organizations having social or scientific objectives, numbered Dr. Jordan among their members.

Dr. Jordan is survived by his son, John William; by Mrs. Hugh Robert Robertson and Andrew Tod Roy, the children of Mrs. Jordan, and by six grandchildren. Besides these, there are many who will feel the loss of Dr. Jordan's sincere friendliness.

KEIVIN BURNS

ALLEGHENY OBSERVATORY

CLARENCE PRESTON GILLETTE

DR. CLARENCE PRESTON GILLETTE, director emeritus of the Colorado Agricultural Experiment Station and emeritus professor of entomology and zoology at Colorado State College of Agriculture and Mechanical Arts, died at his home in Fort Collins, Colorado, on January 4, 1941, after suffering a stroke the day before. He was born in Ionia County, Michigan, April 7, 1859, received his early education in the Michigan public schools, then attended Michigan State College. The bachelor's degree was received there in 1886 and the master's in 1887. The honorary degree of doctor of science was conferred by the same institution in 1916.

Dr. Gillette was assistant in the department of zoology, Michigan State College, until 1888, when he accepted the position of entomologist of the Iowa State College Experiment Station at Ames, Iowa. This work was left in 1891 to accept the head of a new department of zoology, entomology and physiology at Colorado State College. The date of his death lacked just a few days more than a month of being 50 years from the date of his arrival in Fort Collins. In 1907 he became Colorado's first state entomologist, which position he held for 24 years. In 1910, in addition to the two former positions, he was made director of the Colorado Experiment Station, which position he held until his retirement in 1932.

Dr. Gillette was known best for his work in entomology, although he maintained a deep interest in genetics and eugenics and taught classes in these subjects until his retirement. He was an entomologist of the old school, doing work in many parts of the field. Probably few men were better posted on the western economic insect problems. He was an enthusiastic collector and was responsible for the building of a well-balanced, representative insect collection and published systematic papers in several groups. His papers included a list of the Orthoptera and Hemiptera of Colorado and many articles dealing with the Cynipidae, Cicadellidae and Aphidae. His last important work, the Aphidae of Colorado, published jointly with Miss Miriam A. Palmer, describes and illustrates well over 300 species, many of which were new to science. He was a fellow in the American Association for the Advancement of Science and the Entomological Society of America, a charter member of the American Association of Economic Entomologists and its president in 1901, honorary member of the Iowa Academy of Science, member of the Colorado-Wyoming Academy of Sciences, the American Genetic Association and the American Eugenics Society. He was a member of the honor societies of Sigma Xi, Phi Kappa Phi and Alpha Zeta.

Dr. Gillette was a modest, retiring individual, a wise administrator and a teacher who seemed to strike a responsive chord in almost every student. He was active in civic and church affairs and lived an exceedingly useful and well-rounded life.

GEORGE M. LIST

COLORADO STATE COLLEGE

RECENT DEATHS

SIR FREDERICK BANTING, professor of medical research at the University of Toronto and head of the Banting Institute, was killed in the wreck of a military airplane on February 21. Sir Frederick, jointly with Dr. J. J. R. MacLeod, received the Nobel prize for medicine in 1922 for the discovery of insulin.

DR. DAYTON CLARENCE MILLER, honorary professor of physics emeritus at the Case School of Applied Science at Cleveland, died on February 22 in his sixty-fifth year.

DR. JOHN PRESTON SUTHERLAND, dean emeritus of the Medical School of Boston University, died on February 21. He was eighty-seven years old.

DR. WILLIAM CECIL BOSANQUET, fellow of New College, Oxford, died on January 24 at the age of seventy-four years.

DR. KOLTZOFF NIKOLAI KONSTANTINOVICH died in December, in Moscow, at the age of sixty-nine years. A correspondent writes: "A professor at two universities, director of the Institute of Experimental Biology and a former director of the Central Station of Genetics, he is well known and often cited for his publications on genetical analysis of the physiology of heredity and of the structure of protoplasm and living matter in general, and properties of the blood, as well as for his earlier studies on fish anatomy and embryology." He was editor of the *Journal de Biologie Expérimentale* until 1931 and had been editor of the *Journal de Biologie* since 1932.

SCIENTIFIC EVENTS

THE AMERICAN DIABETES ASSOCIATION

THE American Diabetes Association, which for the past three or four years has had several informal meetings, has now been formally organized, with Dr. Cecil Striker of Cincinnati as president. It is planned to have a one-day clinical session in Cleveland at the meeting in June of the American Medical Association.

An official statement gives the objects of the association as follows:

To disseminate among physicians information relative to the diagnosis and treatment of diabetes by means of meetings, bulletins, publications of papers in scientific journals, and through a central office which would at all times make available information concerning various aspects of diabetes.

To educate the laity in the early recognition of diabetes and in the realization of the importance of medical supervision.

To secure and coordinate the active cooperation of associated groups acceptable to the trustees in the educational and organizational phases of the association.

To make and publish statistical surveys of diabetes.

To encourage and support clinical, experimental, sociological and statistical studies by means of grants.

To encourage the adequate treatment of diabetes and the establishment of summer camps for children.

The first number of a new journal devoted to problems associated with diabetes will appear under the auspices of the association in June.

THE AMERICAN SOCIETY FOR TESTING MATERIALS

THE spring meeting of the American Society for Testing Materials will be held on March 4 and 5 at the Hotel Mayflower in Washington, D. C.

Throughout the week beginning on March 3 and extending to March 7, there will be some two hundred meetings of the committees of the society, participating in what is known as Committee Week. During this week various research and standardization projects will be reviewed and recommendations developed which will be included in reports presented at the annual meeting—such as the approval for the first time of new standards, revisions of existing standards, or in the case of tentative standards their adoption as formal standards.

Two technical symposia, one on Color—Its Specification and Use in Evaluating the Appearance of Materials, and the second on New Methods for Particle Size Determination in the Subsieve Range, will occupy three sessions.

The official announcement points out that the growing significance of color with respect to the evaluation of materials, the interest of several standing committees of the society in this subject and its definite interest in the work of the Inter-Society Color Council have resulted in sponsoring this symposium as a joint meeting. M. Rea Paul, director of the Chemical Paint and Color Service of the National Lead Company, is chairman of the committee in charge.

The papers that will form the basis of discussion and the authors who will present them are as follows:

"Introduction to Color," Deane B. Judd, physicist, National Bureau of Standards.

"Color of Transparent Materials," Francis Scofield, chemist, National Paint, Varnish and Lacquer Association, Inc.

"Hiding Power and Opacity," R. H. Sawyer, Krebs Pigment and Color Corporation.

"Color Standards for Opaque Materials," I. H. Godlove, E. I. du Pont de Nemours and Company.

"The Spectrophotometer in the Determination of the Color of Materials," A. E. Parker, Electrical Testing Laboratories.

"Photoelectric Colorimetry," Richard S. Hunter, junior physicist, National Bureau of Standards.

In the evening there will be a popular session entitled "Parade of Color," in which the American Society for Testing Materials will participate. This meeting will be held in the auditorium of the Potomac Electric Power Company.

Through one of its technical committees the society has been for years active in sponsoring papers and developing methods for determining fineness or particle size and in certain fields, notably that of pigments and cement. Rapid developments in this field, particularly with respect to the so-called "air permeability methods," the availability of a new method of magnification reaching far beyond anything heretofore available, and other factors pointed to the value which would result from a symposium on this subject. C. E. Barnett, of the New Jersey Zinc Company, who has arranged the symposium, is chairman of the subcommittee on the size and shape of pigment type materials.

The program follows:

"A New Method for Measuring the Surface Areas of Finely Divided Materials and Its Use in Determining the Size of Particles," Professor P. H. Emmett, the Johns Hopkins University.

"The Adsorption of Pigments," Professor W. W. Ewing, Lehigh University.

"The Determination of Subsieve Particle Size Distributions by Sedimentation Methods" Dr. S. W. Martin, National Lead Company.

"The Shape and Surface of Fine Powders by the Permeability Method," Professor P. C. Carman, University

of Cape Town (to be presented by some American technologist).

"Methods for Determining Particle Size Distribution," L. T. Work, Metal and Thermit Corporation, and Herbert Schweyer, Columbia University.

"Surface Area of Portland Cement," Paul S. Roller, physical chemist, Eastern Experiment Station, U. S. Bureau of Mines, and P. V. Roundy, Jr., cooperative fellow, American Instrument Company.

"RCA Electron Microscope," James Hillier, RCA Laboratories.

AWARD OF THE LAMME MEDAL OF THE AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS

THE 1940 Lamme Medal of the American Institute of Electrical Engineers has been awarded to Comfort Avery Adams, consulting engineer of the Edward G. Budd Mfg. Co., Philadelphia, "for his contributions to the theory and design of alternating current machinery and his work in the field of electric welding." The medal and certificate will be presented to him at the annual summer convention of the institute, which is to be held in Toronto, from June 16 to 20.

The Lamme Medal was founded as a result of a bequest of the late Benjamin G. Lamme, chief engineer of the Westinghouse Electric and Manufacturing Company, who died on July 8, 1924, to provide for the annual award by the institute of a gold medal (together with a bronze replica thereof) to a member of the American Institute of Electrical Engineers, "who has shown meritorious achievement in the development of electrical apparatus or machinery" and for the award of two such medals in some years if the accumulation from the funds warrants. A committee composed of nine members of the institute awards the medal.

Mr. Lamme made similar bequests to the Society for the Promotion of Engineering Education and to the Ohio State University, providing in the former for the annual award of a medal "for accomplishment in technical teaching or actual advancement of the art of technical training," and in the latter for the annual award of a medal to a graduate of the Ohio State University in any branch of engineering for meritorious achievement in engineering or the technical arts. The three organizations adopted a common obverse for their medals, and each prepared a suitable reverse.

Previous awards of the Lamme Medal of the American Institute of Electrical Engineers were: 1928, Allan B. Field; 1929, Rudolf E. Hellmund; 1930, William J. Foster; 1931, Giuseppe Faccioli; 1932, Edward Weston; 1933, L. B. Stillwell; 1934, Henry E. Warren; 1935, Vannevar Bush; 1936, Frank Conrad; 1937, R. E. Doherty; 1938, Marion A. Savage; and 1939, Norman W. Storer.

THE AMERICAN INSTITUTE OF MINING AND METALLURGICAL ENGINEERS

THE American Institute of Mining and Metallurgical Engineers was held in the Engineering Societies Building, New York, from February 7 to 20.

The Medals and Honors of the institute were presented at the annual banquet at the Commodore Hotel on the evening of February 19. The list follows:

The William Lawrence Saunders Gold Medal to Herman C. Bellinger, "for distinguished service to the mining industry during the period of its modern development, as engineer, manager and executive officer of important mining companies. For his contribution to the arts of mining in the United States, Canada, Mexico, Australia and South America, and particularly for the successful initiation and adoption of improved methods, practices and procedures at the Chuquicamata copper mine in Chile."

The Anthony F. Lucas Medal to Conrad Schlumberger, posthumously, and Marcel Schlumberger, his brother, "for development of the art of electrical coring or electrical logging. Electrical logging has proved of immense value in interpreting underground structure, locating faults, thereby assisting in the finding and production of oil. Utility of shotgun perforation, stage-cementing and various other inventions are subsidiary to and dependent upon successful electrical coring."

The Charles F. Rand Gold Medal to Robert Crooks, "for his pioneering leadership during a period of active growth and development of a world-wide enterprise involving the mining of nickel ores, the metallurgical treatment thereof and the expansion and diversification of world markets for nickel products. For his able direction of the corporation encompassing these activities, which has established an enviable record in its relations with employees, stockholders and with the public."

The Robert W. Hunt Awards for 1941 to Alden B. Greninger and Alexander R. Troiano, for their paper, contributed to the institute, entitled "Crystallography of Austenite Decomposition," and to G. E. Steudel, for his paper, contributed to the institute, entitled "Effect of the Volume and Properties of Bosh and Hearth Slag on Quality of Iron."

The J. E. Johnson, Jr., Award to Karl F. Hoffmann, for his paper, presented to the institute, entitled "Manufacture of Low-silicon Pig Iron Using High Blast Temperatures."

The Division Award for 1941 of the Institute of Metals was presented at the dinner to S. E. Maddigan and A. I. Blank, for their paper entitled "Recovery and Recrystallization in Long-time Annealing of 70-30 Brass." Dr. Maddigan is research physicist, and Mr. Blank, research assistant, at the Chase Brass and Copper Company, Waterbury, Conn.

A PROPOSED SOUTHERN SCIENTIFIC SOCIETY

AT the meeting of the Alabama Academy of Science on March 29 and 30, 1940, it was agreed that the Ala-

bama Academy would sponsor a meeting of southern scientists in 1941. Therefore, plans have been made for a meeting of those who wish to attend from a large Southern area. No very definite geographic limits have been set, the idea being to welcome any interested southern scientists. Representative attendance from several states is already assured.

In SCIENCE, July 5, 1940, there appeared an unusually cogent article entitled "Scientific Research the Hope of the South," by Professor George D. Palmer, of the University of Alabama. This article was doubtless caused partly by preceding discussions. It certainly has been the cause of much subsequent discussion and planning. Persons who have not read that article will enjoy doing so, and many will think of additions that they would like to make upon that topic. Helping in the plans for the meetings in Mobile on March 20 and 21 are many individuals, industrial and educational institutions, and such successful scientific bodies as the Southern Biologists Association, the Southeastern Branch of the American Meteorological Society and others. The Alabama Academy of Science is acting as planning host.

The major immediate purpose of the Mobile meeting is to consider the desirability of organizing a Southern or Southeastern Scientific Society. There will be a program of scientific papers. There will be abundant provision for discussion of scientific discoveries, needs and opportunities. There will be a dinner of southern scientists on Thursday evening, the twentieth, and a dinner of the Alabama Academy on Friday evening, the twenty-first. Those desiring to participate in the meetings, or to make dinner reservations, should write to Professor George D. Palmer, University, Alabama.

Perhaps it should be stated that the proposed Southern Scientific Society would not necessarily be affiliated with the American Association for the Advancement of Science. The General Secretary of the association is a delegate to the Mobile meeting for the purpose of cooperating in any service for science and citizens.

OTIS W. CALDWELL
General Secretary of the American Association for the Advancement of Science

SCIENTIFIC NOTES AND NEWS

SCIENTIFIC men who are included in the list of New Year honors conferred by King George are: *Baronet,* Dr. Hugh Lett, president of the Royal College of Surgeons of England; *Knight Commander of the Bath,* Dr. Edward Victor Appleton, secretary of the Department of Scientific and Industrial Research, previously Jacksonian professor of natural philosophy at the University of Cambridge; *Knight Bachelor,* Dr. William Lawrence Bragg, Cavendish professor of experimental physics at the University of Cambridge, who will be known as Sir Lawrence Bragg, and Dr. John Sealy Edward Townsend, Wykeham professor of physics at the University of Oxford; *Companion of St. Michael and St. George,* Dr. Robert Thomson Leiper, professor of helminthology at the University of London.

THE honorary degree of doctor of science has been granted by the National University of Ireland to Dr. Gordon M. Holmes and Dr. F. M. R. Walshe, consulting neurologists in London, "in view of their distinction as neurologists, and in recognition of their valuable contributions to medical literature," and to Professor Ernest William Hay Groves, professor emeritus of surgery at the University of Bristol, "in view of his eminence as an orthopedic surgeon, and an internationally recognized authority on the literature of his subject." Dr. Walshe was visiting neurologist at the Johns Hopkins Hospital in 1925.

FOR "outstanding work in physics" Professor A. F. Joffe, member of the Academy of Sciences of the U.S.S.R., has been awarded the Order of Lenin, the highest honor of the Soviet Union. The award was made on the occasion of his sixtieth birthday, in recognition of work on the mechanical and electrical properties of crystals, on the photoelectric effect, on the magnetic field of projectiles and on the manufacture of plastic synthetic rubber.

THE Civic Achievement Medal of the Municipal Museum Commission of Rochester, N. Y., was presented on February 19 at the annual convocation of the commission to Frank William Lovejoy, president of the Eastman Kodak Company. The first medal was awarded in 1938 to Dr. Herman Le Roy Fairchild, professor emeritus of geology at the University of Rochester, who celebrated his eighty-fifth birthday on April 29 of that year.

DUE to the illness of Dr. Alexander Silverman, head of the department of chemistry of the University of Pittsburgh, the Pittsburgh Section of the American Chemical Society has postponed the presentation of the Pittsburgh Award for 1940 from February 20 to March 20. It will be presented to Dr. Silverman at a dinner at the University Club in Pittsburgh preceding the March meeting of the section. Dr. William Lloyd Evans, head of the department of chemistry at the Ohio State University and president of the American Chemical Society, will attend the dinner and will address the section that evening.

DR. ERNST MAYR, associate curator of the Whitney-Rothschild Collection of the American Museum of Natural History, New York, and Dr. Edgar Anderson, professor of botany at Washington University, St. Louis, and geneticist of the Missouri Botanical Garden, have been named Jesup lecturers in the department of zoology at Columbia University. These lectures were endowed in 1905 by the late Morris K. Jesup, president of the American Museum of Natural History and of the New York Chamber of Commerce, "to present in popular form the results of recent scientific discoveries." "Speciation and Evolution" will be the subject of this year's lectures. They will be given on Tuesdays and Thursdays each week from March 4 to March 27 in Schermerhorn Hall, Columbia University.

WALTER S. WEEKS, professor of mining at the University of California, has been elected president of the San Francisco section of the American Institution of Mining and Metallurgical Engineers.

FRED A. MENNERICH, of the Textile Laboratory of Jersey City, N. J., has been elected president of the New York Microscopical Society.

DR. DIRK BROUWER, associate professor of astronomy at Yale University, has been promoted to a full professorship and has been appointed director of the observatory in succession to Dr. Frank Schlesinger, who will retire in June.

DR. FRANCIS G. BLAKE, Sterling professor of medicine, acting dean of the School of Medicine of Yale University, has been made dean. Dr. William T. Salter, of the Thorndike Memorial Laboratory at the Boston City Hospital, has been appointed professor of pharmacology.

DR. JOHN A. TIMM, assistant professor of chemistry at Yale University, has been appointed professor of chemistry, director of the School of General Science and chairman of the division of science at Simmons College. He will succeed Dr. Kenneth L. Mark, who will retire at the close of the academic year.

DR. REED C. ROLLINS, for the past three years a member of the Society of Fellows of Harvard University, took up his work as instructor in biology (botany) and curator of the Dudley Herbarium at Stanford University on January 2. Dr. Rollins has taken over part of the instruction and herbarium work of Professor Ira L. Wiggins, who became director of the Natural History Museum last September, following the retirement with the rank of emeritus professor of biology (botany) of Professor LeRoy Abrams.

DR. WESLEY C. MITCHELL, professor of economics at Columbia University, president in 1938 of the American Association for the Advancement of Science, has leave of absence from the university for the coming academic year. Dr. Douglas Johnson, professor of physiography, has leave of absence for the spring semester.

DR. T. L. ALTHAUSEN, associate professor of medicine at the Medical School of the University of California, San Francisco, will give a course this summer on "Fundamentals of Health and Disease at the University of Hawaii."

DR. MAZYCK P. RAVENEL, professor emeritus of preventive medicine and bacteriology of the School of Medicine of the University of Missouri, editor-in-chief of the *American Journal of Public Health,* has become editor emeritus. He is succeeded by Dr. Harry Stoll Mustard, director of the DeLamar Institute of Public Health of Columbia University.

DR. GERRIT S. MILLER, JR., for thirty-one years curator of mammals in the United States National Museum, retired on January 13, after serving the museum for forty-two years. Dr. Miller is continuing his work as an associate in biology.

DR. CLARENCE A. SKINNER has retired as chief of the division of optics of the National Bureau of Standards and has been succeeded by Dr. Frederick Bates, who has been connected with the bureau since 1903. Dr. J. Franklin Meyer, because of ill health, has resigned as chief of the section of photometry. Dr. J. H. Dellinger, chief of the radio section of the bureau, has been made chairman of the recently revived Radio Technical Committee for aeronautics in the Department of Commerce.

DR. HERBERT T. KELLY has been appointed chairman of the Committee on Nutrition of the Medical Society of the State of Pennsylvania. This is a newly formed committee. Its plans include the dissemination of the newer knowledge of nutrition, and the causes, prevention, early recognition and medical management of nutritional deficiency.

DR. L. B. DUNNING has been elected chairman of the New York Bureau of Dental Information.

DR. ARTHUR B. CLEAVES, formerly of the Pennsylvania Topographic and Geologic Survey, has resigned his position as geologist for the Pennsylvania Turnpike Commission to become chief geologist for Caribbean Architect-Engineer. He will be engaged in geologic work connected with the new U. S. military bases to be established in the British West Indies.

DR. JUSTUS MUELLER, of the New York State College of Forestry at Syracuse University, has been elected a member of the editorial board of the *Journal of Parasitology,* the official publication of the American Society of Parasitologists.

FRANK C. FLETCHER has been made head of the department of entomology of Ward's Natural Science Establishment, Rochester, N. Y.

DR. DETLEV W. BRONK, professor of physiology and chairman of the department of physiology and biophysics at the Cornell University Medical College, New York City, will deliver the fifteenth annual series of Priestley Lectures at the Pennsylvania State College, from March 2 to 11. The lectures, a series of five, will commemorate the two hundred and eighth anniversary of the birth of Joseph Priestley.

DR. OTTO LOEWI, research professor of pharmacology at the New York University College of Medicine, delivered the Dohme Lectures 1940–1941 at the Johns Hopkins University School of Medicine on January 21 and 22. He spoke on "Humoral Transmission of Nervous Impulse."

PROFESSOR WALTER F. LOEHWING, professor of botany and head of the department at the State University of Iowa, on February 13 gave an illustrated lecture at the University of Illinois under the auspices of the Division of Biological Sciences. His subject was: "The Developmental History of Plants—Appraisal of Recent Advances."

DR. H. E. EDGERTON, associate professor of electrical measurements at the Massachusetts Institute of Technology, spoke at the February meeting of the American Academy of Arts and Sciences on "Stroboscopic Light and its Applications," and Dr. Dard Hunter, curator of the Dard Hunter Paper Museum of the institute, presented an exhibit on "An Experiment in Fifteenth Century Type Making."

DR. A. O. C. NIER, professor of physics at the University of Minnesota, gave on February 11 and 12 two lectures at the Iowa State College. They related to the measurement of relative abundances and separation of isotopes, and to the use of isotopes as tracers in chemical and biochemical problems.

THE International Association for Dental Research will hold its annual general session at the Jefferson Hotel in St. Louis on March 14 and 16. The American Association of Dental Schools will meet at the same place from March 17 to 19, inclusive.

THE annual meeting of the Electrochemical Society will be held in Cleveland from April 16 to 19. Headquarters will be at the Hotel Cleveland. At the meeting of the Board of Directors held in conjunction with the Ottawa Convention it was unanimously decided to establish a new type of membership in the society, namely, "Sustaining Membership." Dues for this type of membership are $100 for one year or $500 for five years. Up to the beginning of the present month twenty-two individuals and corporations had responded.

A SECOND Midwest Conference on Spectrographic Analysis will be held in the Kent Chemical Laboratory at the University of Chicago on Saturday, March 29. Because of the growing importance of absorption spectroscopy, this year's conference will be held in two divisions, one dealing with emission spectra, the other with absorption spectra. The former is being organized by W. C. Pierce, of the University of Chicago, and the latter by Elmer Miller, of the University of Minnesota. Further information and copies of the final program may be obtained from either of these.

THE twenty-fourth annual meeting of the American Society of Ichthyologists and Herpetologists will be held at the University of Florida from April 3 to 5. All sessions will be held in the Chemistry Auditorium. The annual dinner will be given at the White House Hotel, Gainesville, the headquarters, on Thursday, April 3, and an out-of-door supper is planned for the evening of April 4. Excursions to various points of interest have been arranged. There will be a meeting of the Board of Governors on Wednesday evening, April 2. The titles of papers to be presented at the meeting must be in the hands of the secretary of the local committee before March 1. Accommodations in other hotels and in private homes are also available. Reservations may be made by writing to the White House Hotel, Gainesville, or to the secretary of the Local Committee, C. J. Goin, Department of Biology of the University of Florida.

IN addition to the examinations already reported in SCIENCE, the U. S. Civil Service Commission, Washington, D. C., announces examinations for the positions of senior pharmacologist, with a salary of $4,600 a year; of pharmacologist, $3,800; of associate pharmacologist, $3,200, and of assistant pharmacologist, $2,600. Applications will be rated as received by the commission during 1941, and certification will be made as the needs of the service require, except that if sufficient eligibles are obtained applications may be closed, in which case due notice will be given. An examination is also announced to fill positions as chemical analyst. The salary of senior chemical analyst is $2,000 a year, and that of assistant chemical analyst, $1,620. Applicants are desired who are skilled in the standard methods of analysis used in commercial laboratories. Applications must be on file not later than March 13. Applications must be filed not later than March 10 for the position of radio inspector in the Federal Communications Commission at $2,600 a year, and assistant radio inspector in various departments at $2,000. The work of these positions involves radio inspection work of all kinds. These salaries are subject to a 3½ per cent. retirement deduction. Further information and application forms may be obtained from the secretary of the Board of U. S. Civil Service

Examiners at any first- or second-class post office, or from the U. S. Civil Service Commission, Washington, D. C.

THE Central Scientific Company, Chicago, invites applications in chemistry or mathematics or both, for the Cenco Industrial Fellowships, with stipends of $1,200. Two fellows, and possibly three, will be selected from the applicants. Preliminary selection will be made on the basis of replies to questionnaires, scholastic standing and recommendations. The final selection will be made by examination and interview. Fellows will be under the supervision of the director of research and development, but will be given experience in other departments of the company. Application blanks may be secured on request from Dr. M. N. States, Central Scientific Company, 1700 Irving Park Road, Chicago, Ill.

DISCUSSION

NOTE ON AN ERRONEOUS STATEMENT CONCERNING PRE-NOVA STARS

IN reading a recent popular book the writer encountered a surprising statement which is indicative of the wide-spread misinformation about the pre-outburst condition of novae. Taken by itself the statement may seem very trivial, but its implications are so far-reaching that it can not be allowed to pass. It has happened too often in the history of science that an eminent authority has given misinformation which, because of the weight carried by the author's name, has been passed on from one text to another for decades. The repetition of such occurrences can be avoided only if those who notice them take it upon themselves to expose the errors mercilessly, instead of tolerantly passing them by as just a few incorrect statements among thousands of correct ones.

The offending paragraph occurs in "The Birth and Death of the Sun," by Professor George Gamow. In regard to the pre-nova state he writes on page 182:

> Only in the case of Nova Herculis, which flashed on the northern sky in mid-December, 1934, had the spectrum been photographed occasionally before the explosion. And the spectrogram reveals that before the explosion this star was not much different from any other star of the main sequence. In fact, its absolute luminosity and its spectral characteristics were very close to those of our Sun. Does this mean that our Sun is also destined to burst in a not very distant future?

There are two errors here. In the first place, the lone nova whose spectrum was observed before outburst was not Nova Herculis, but Nova Aquilae 1918. Secondly, the faint spectrum observed was *definitely not* of solar type. According to Miss Cannon,[1] it could not be classified, but was surely of "early" type, since the energy distribution of the continuous spectrum resembled that of class B or A.

On the correctness or incorrectness of statements concerning the pre-nova condition of stars hinges the important question of the cause of the nova outburst, as well as one of great popular interest, *viz.*, whether the sun will some day become a nova. The remark that the pre-nova star "was not much different from any other star of the main sequence" definitely conveys to the reader the idea that normal well-behaved stars become novae. This is a rash generalization to make, and indeed there are good observational grounds for believing that such a view is incorrect.

It is worth while to seek out the origin of the errors made by Professor Gamow. The misidentification of the nova was probably just a confusion which arose in remembering a large number of facts, and it is the less important of the two errors. The incorrect statement concerning the spectrum is pretty surely to be traced to a number of conjectural statements which were published concerning Nova Herculis. Thus, Grotrian[2] refers to it as a dwarf star of about class K 5. But this is merely an adoption of a similar statement made by Beileke and Hachenberg.[3] And these authors in turn quote Guthnick[4] as authority for their statement. Just which of these sources gave Professor Gamow his "facts" is not important. The thing that is of importance, in the writer's opinion, is that *a conjecture or pure assumption has been passed on as if it were an established fact.* May we now expect that for years to come, Gamow will be quoted as authority for the statement that stars in the pre-nova state have characteristics practically identical with those of the sun? I hope not!

The full discussion of this question of the nature of the pre-nova star will be published elsewhere. There are good reasons for adopting as a working hypothesis[5] the idea that the pre-nova stars are practically identical with the post-nova objects: sub-dwarfs of visual absolute magnitude +4, bolometric absolute magnitude 0, temperature 40,000 to 50,000°K, radii of order 0.1 ⊙ to 0.2 ⊙, and densities of order 200 ⊙. They are

[1] *Harvard Annals,* 81: 179, 1920.

[2] *Zeitschrift für Astrophysik,* 13: 217, 1937.
[3] *Zeitschrift für Astrophysik,* 10: 372, 1935.
[4] *Naturwiss.,* 23: 249, 1935.
[5] *Cf.* Biermann, *Zeitschrift für Astrophysik,* 18: 344, 1939.

definitely too luminous and not sufficiently dense to be considered true white dwarfs.[6]

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SOUTHERNMOST GLACIATED PEAK IN THE UNITED STATES

SAN GORGONIO PEAK[1] (elevation 11,485 feet, Latitude 34° 6′ N.) in southern California has been considered the southernmost glaciated peak in the United States.[2] It is not generally known that a more southerly glaciation occurred on Cerro Blanco (elevation 12,003, Latitude c. 33° 23′ N.) in northern Otero County, New Mexico. Although Stone[3] was unsuccessful in seeking evidences of glaciation in the Sierra Blanca range, Ellis[4] later reported finding a cirque and hummocky morainic deposits on Cerro Blanco, highest peak in the range, and Antevs[5] independently suggested the probability of glaciation on the basis of observations made with field glasses some distance from the peak.

Since the southern limit of glaciation has important climatic, geomorphic and ecological implications, the writers undertook to ascertain the status of glaciation on Cerro Blanco, and, in August, 1940, ascended the peak from both the southeastern and northeastern sides. A single well-developed cirque was found on the peak and occurs on the northeastern side. From the cirque a steeply sloping glaciated valley more than half a mile in length leads down toward the north fork of Rio Ruidoso. Well-defined moraines are present, and there is a pro-talus rampart within the cirque. These facts establish Cerro Blanco as the southern limit of mountain glaciation in the United States.

All the glacial features are fresh and essentially unmodified save by frost weathering, thus indicating Wisconsin age for the glaciation. The complexity of the Wisconsin Stage of glaciation, already reported for the Southern Rocky Mountains,[6] is indicated also by the glacial deposits on Cerro Blanco.

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[6] *Cf.* Humason, *Astrophysical Journal*, 88: 228, 1938.
[1] H. W. Fairbanks and E. P. Carey, SCIENCE, 31: 32–33, 1910.
[2] N. M. Fenneman, "Physiography of Western United States." New York: McGraw-Hill Book Co., pp. 498–499, 1931.
[3] G. H. Stone, SCIENCE, 14: 798, 1901.
[4] R. W. Ellis, *New Mex. Univ. Bull.*, Geol. ser., 5: 1, 24–25, 1935.
[5] E. Antevs, *Proc. Acad. Nat. Sci. Philadelphia*, 87: 306–307, 1935.
[6] L. L. Ray, *Bull. Geol. Soc. Amer.*, 51: 1851–1918, 1940.

A SUGGESTION FOR THE MAINTENANCE OF SCIENTIFIC ILLUSTRATIONS

DURING the past year various technical publications have announced their inability to retain the blocks, electroplates, etc., used in illustrating their papers (in the case of two entomological journals this year). For the most part, these blocks were to be destroyed, not because of lost value but because the society sponsoring the publication was unable to afford the space necessary for storage of this material.

It has been my fortune to sort through the accumulated illustrations of one of these journals, and most of the material seen would be very difficult to duplicate; some of it could not be duplicated at all. A great many of these plates and blocks would be used again were they available to authors throughout the country. A number of the illustrations are not available in print; I had tried fruitlessly to secure an old copy of a certain paper for several months and had decided that there was no available copy to be had. When I sorted these blocks I discovered the perfect, original electroplates of this paper. It would certainly cost but little to have several copies of these plates printed. So there exists, I believe, a sound reason why these plates should be kept, even if the authors do not claim them.

It would be much to the credit of the country to preserve this expensive and valuable material rather than permit it to be melted for scrap. It is not impossible to collect all the valuable accumulated plates in some central library and make them available, on loan, to authors or to people who wish to reproduce them for study, etc. Could not the Library of Congress or some other responsible institution be persuaded to keep these plates resulting from the nation's private research?

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CATALOGUES OF CURRENT SCIENTIFIC LITERATURE

IN his recent article, on "The Distribution of the Periodical Literature of Science,"[1] Dr. Atherton Seidell suggests, as a plan to acquaint research workers with the current literature, "the publication of current classified catalogues of the titles of papers appearing in scientific periodicals." For entomological literature, such a plan has been in operation in *Entomological News* (published by the American Entomological Society, at the Academy of Natural Sciences, Philadelphia) since 1890 with few interruptions. The

[1] SCIENCE, 93: 2402, 38–39, January 10, 1941.

issue for January, 1941 (there are ten issues each year) devotes 11½ of its 30 pages to the monthly list of "Entomological Literature," comprising 200 titles under 9 headings, both taxonomic and non-taxonomic. Under each heading the authors' names are arranged alphabetically.

PHILIP P. CALVERT

CHEYNEY, PA.

SCIENTIFIC BOOKS

STRENGTH AND STRUCTURE OF THE EARTH

Strength and Structure of the Earth. By REGINALD ALDSWORTH DALY. New York: Prentice-Hall. 1940. Pp. ix + 434; 83 figs., 69 tables, biblgr., index. $3.50.

ISOSTATIC equilibrium and the strength of the earth's crust are subjects that loom ever larger in connection with problems of geotectonics. Geologists appreciate readily enough the great importance of these subjects, but are somewhat appalled by their magnitude, difficulty and apparent elusiveness. One serious handicap for students in this field has been the scattered and undigested character of the large literature containing the pertinent data. There has been a crying need for summation and evaluation of these data, by an informed geologist, for the use of geologists. The new volume by Professor Daly is an answer to this need. Four fiifths of the book is devoted to the growth of the concept of isostasy, the geodetic data on which the concept is based and geologic evidence bearing on the problem. With the factual materials are presented interpretations made by leading investigators. In a final chapter the author makes his own analysis, and suggests a model of the earth that will harmonize with the facts of geodesy and geology.

Hayford's laborious study based on deflections of the vertical, the first quantitative test of an old theory, is explained in some detail. Advantages of the gravimetric method are made clear; a major advantage is the practicability of determining gravity anywhere at sea, where triangulation on which the deflection method depends is impossible. It will be news to some readers that there are as many as five methods of reducing gravity values, all assuming isostatic compensation of topography. The chief advantage of the Hayford-Bowie method, based on the Pratt concept of compensation at uniform depth, lies in the relatively simple calculations involved. Heiskanen has used two forms of the Airy hypothesis, which assumes variable thickness of a light crust. The G. R. Putnam and Venig-Meinesz reductions are based on assumption of regional compensation, which from the geologic viewpoint is more reasonable than strictly local compensation. Anomalies derived by the several methods differ among themselves; and anomalies obtained by any one of the methods can be varied by changing from one spheroid of reference to another. In 1938 Heiskanen proposed a triaxial spheroid, of which the major equatorial axis is 704 meters longer than the minor axis. Daly favors this triaxial figure of reference, and uses it in his speculative model earth.

In 1932 Glennie, of the Survey of India, challenged the entire concept of isostasy as it applies to India. He showed that the crests and troughs of the Indian geoid do not correspond to topography in accordance with Hayford's concept; and that the Hayford anomalies, based on the international spheroid, have a large average negative value for the entire peninsula, with negative values of more than 100 milligals in the Gangetic plain. Using a new spheroid of reference, and assuming that the anomalies reflect strong warping of a heavy crustal layer at depth, Glennie calculated anomalies of a new type—"warp anomalies"—which are positive in a broad east-west belt, negative in flanking belts to the north and south. The average of "warp anomalies" for the entire peninsula is not far from zero. It appears, therefore, that Glennie has demonstrated for India not a lack of isostasy, but broadly regional isostasy. Indeed, his very attempt to explain the anomalies as caused by crustal warping seems to suggest an unconscious assumption that before warping occurred the region was in perfect isostatic balance. Hunter, commenting on gravity conditions in India, suggests that the term isostasy should be dropped, because it has become synonymous with "Hayford isostasy," which is disproved for the Indian peninsula. Daly correctly remarks that Hunter's suggestion is based on a misconception. Isostasy, meaning either the tendency for disappearance of stresses caused by shift of load, or actual equilibrium in the crust, is not confused, in the minds of thoughtful students, with Hayford's artificial assumption of local compensation at a uniform depth.

Daly finds that the average of negative anomalies in India is much reduced if reference is made to Heiskanen's 1938 triaxial spheroid. Anomalies for India given by this reduction are comparable, as a regional group, to those in Fennoscandia, a region of comparable size. There is striking contrast, however, in the behavior of these two regions: Fennoscandia is rising as if to restore equilibrium, whereas there is no indication that uplift is occurring in India. The distribution of the Indian anomalies suggests strongly that the crust has been warped in front of the Himalayan arc. Possibly orogenic pressure has increased the capacity

of the crust to bear vertical stresses, distributed in alternating belts of positive and negative load. Daly selects peninsular India as the continental region of greatest demonstrated departure from isostasy and therefore the region best adapted to give a measure of strength in the continental crust. He estimates from the anomalies a maximum stress-difference in India of 400 kilograms per square centimeter. Similar estimates for Hawaii and the Mindanao Deep indicate considerably larger stress-differences in the Pacific floor, and lead to agreement with Barrell that the sub-Pacific part of the lithosphere is much stronger than the continental part.

An estimate of the order of strength in the asthenosphere is furnished by Fennoscandia. In the area of maximum uplift there is a defect of mass equal to a plate of granite about 200 meters thick; this value is deduced from the anomalies, and also from the measured rates of uplift since the ice disappeared. Using a stress diagram prepared by Timoshenko, Daly estimates that at a depth of 100 kilometers under the center of the Fennoscandian tract the stress-difference can not exceed 4 kilograms per square centimeter. Thus the degree of strength indicated for the asthenosphere is at least two orders of magnitude smaller than the estimates of Barrell and Jeffreys.

The hypothesis of a thin, strong lithosphere resting on a subcrust devoid of strength accords with evidence that orogeny is accompanied by horizontal shearing of a superficial shell over its foundation. Daly finds that the concept serves also to clarify some of the larger facts of igneous geology. However, an asthenosphere of unlimited depth is not compatible with Heiskanen's triaxial spheroid as the preferred figure of reference in gravity reductions. The major axis of this assumed figure emerges at 25° west longitude and 155° east longitude; the minor axis, at 115° west longitude and 65° east longitude. In Daly's view, the chief groups of regional one-sign anomaly are explained most logically in reference to the triaxial figure. In an attempt to harmonize the two concepts—a strengthless asthenosphere and a triaxial earth—Daly suggests that the asthenospheric shell is thin, and that it rests on a thick *mesospheric* shell which is strong enough to bear the stresses implied by the triaxial form. The suggested shells are, therefore, from the surface downward: (1) the lithosphere, 60 to 80 kilometers thick; (2) the asthenosphere, with a maximum thickness of about 400 kilometers and possibly much less; (3) the mesosphere, nearly 2,500 kilometers thick and resting on the central core. Daly recognizes that this hypothesis excludes the concept of deep-seated convection as a mechanism to explain crustal deformation. The two hypotheses must compete with each other.

To the reviewer the concept of a thin shell devoid of strength between shells of high strength seems artificial and open to grave doubt. Could such an arrangement be stable, even if it could be brought about? The question of stability arises also in connection with triaxiality supposed to be maintained in the mesosphere. If the assumed small asymmetry produces a figure of disequilibrium in the mesosphere, would not the lack of strength in the surrounding asthenosphere permit compensating adjustments, thus erasing the asymmetry for the earth as a whole? The problem is very difficult, but in a "naturalistic" analysis this criticism seems warranted. Readers will appreciate, of course, that Professor Daly is "going all out" in an attempt to grapple with a stupendous problem. As he says, "To make any progress with the present question, we can not avoid pyramiding speculative ideas."

In this discussion of major issues, one critical comment on terminology may be permitted. Daly adopts Gutenberg's suggested term *mantle* for the entire composite shell of the earth outside the central core. Introduction of this usage into the literature seems unfortunate, because the term *mantle rock,* commonly shortened to *mantle,* has long been in use with another meaning. Even without this objection the appropriateness of the term as Gutenberg uses it may be challenged, since a mantle suggests a superficial covering, whereas the feature in question comprises five sixths of the volume of the earth. The reviewer realizes the need of a short term to designate the entire unit surrounding the central core, but protests the adoption of "mantle" for the purpose.

We are indebted to Professor Daly for a highly useful study, involving much labor on his part and designed to make the way easier and more profitable for future students. In spite of the difficult character of the subject-matter, the book has the pleasing literary quality that characterizes Daly's writings generally. Whatever may be the reactions to interpretations and hypotheses proposed by the author, the book has no rival as a comprehensive guide to a subject of increasing importance in geology.

CHESTER R. LONGWELL

YALE UNIVERSITY

SOCIETIES AND MEETINGS

THE ANNUAL MEETING OF THE SOUTHWESTERN DIVISION

THE twenty-first annual meeting of the Southwestern Division of the American Association for the Advancement of Science will be held at Lubbock, Texas, on April 28, 29, 30 and May 1, 1941. This

will be the second meeting of the division in this city, the previous one having been held here in 1934. Lubbock is located in the center of the South Plains area of Northwest Texas. It is approximately one hundred miles east of the New Mexico border, three hundred miles west of Fort Worth, and one hundred twenty-five miles south of Amarillo. The city is easily accessible by rail over the main line and several branch lines of the Santa Fe, and over a branch line of the Fort Worth and Denver. Well-paved highways, including U. S. 84 and 87, lead out radially from Lubbock in many directions, a fact which is responsible for its often being designated as the "hub of the Plains."

The host institution, the Texas Technological College, was founded in 1925 and now has a regular student body of about 4,300 in the nine-month session. Many changes will be evident to members of the association who have not visited Lubbock and the campus of Texas Tech since the 1934 meeting. A number of new buildings, including four large dormitories, a library building and a press building of an aggregate cost of about two million dollars have been erected on the campus since that time. The city itself has grown from a population of 20,000 to approximately 35,000, exclusive of college students.

Among the organizations meeting with the Southwestern Division may be mentioned the Clearing House for Southwestern Museums, the Council of Texas Archeologists, the Mathematical Association of America, Southwestern Division, the Texas Academy of Science, West Texas Division and the West Texas Museum Association.

In addition to papers presented in the sections devoted to Biological Sciences, Mathematics, Physical Sciences and Social Sciences, the program will include the annual Powell Lecture, to be given this year on Tuesday evening by Dr. Bernadotte Everly Schmitt, Andrew MacLeish distinguished service professor at the University of Chicago, and Pulitzer Prize winner in 1931. The selection of Dr. Schmitt seems rather timely, since he is an authority on European history and was awarded the Pulitzer prize for his work, "The Coming of the War 1914," published in 1930. On Wednesday evening, immediately following the annual banquet, Dr. C. V. Newsom, of the Department of Mathematics of the University of New Mexico, will give his address as retiring president of the division on the subject, "Mathematics and Science."

Members attending the meeting are promised a variety of entertainment and recreation, starting with a reception given on Monday afternoon by President and Mrs. Clifford B. Jones of the college at their home on the campus. Field trips will emphasize the archeology, biology, geology and horticulture of the high plains and their canyons. Points of interest include the State Experiment Station, Blanco Canyon and Yellow House Canyon. In addition, visits may be either en route or by special arrangement to the vertebrate fossil beds near Dickens (east of Lubbock), the gas and oil fields and the helium plant of the United States Bureau of Mines near Amarillo, the archeological sites of the Canadian River Valley and the Palo Duro State Park. Points of interest for those coming from greater distances include the newly dedicated McDonald Observatory in the Davis Mountains near Alpine, Texas, the Carlsbad Caverns and the salt mines near Carlsbad, New Mexico. The recent development at Carlsbad of a gigantic potash industry by the United States Potash Company, the Potash Company of America and the Union Potash and Chemical Company should be of especial interest to chemists and geologists. Short trips of not over a half day will be featured in Lubbock and the immediate vicinity. Longer trips, going farther afield, will be arranged if there is sufficient demand.

Dr. Wm. M. Craig, of the Department of Chemistry of the Texas Technological College, is in charge of a large local committee arranging for the meeting. Officers of the various sections are as follows:

Biological Sciences: Chairman, Harold M. Hefley, Lubbock; *Secretary,* Alvin R. Grove, Albuquerque.

Mathematics: Chairman, E. J. Purcell, Tucson; *Vice-Chairman,* Roy MacKay, Portales; *Secretary,* Harold D. Larsen, Albuquerque.

Physical Sciences: Chairman, Franklin E. Roach, Tucson; *Secretary,* Oscar B. Muench, Las Vegas.

Social Sciences: Chairman, W. C. Holden, Lubbock; *Secretary,* William M. Pearce, Lubbock.

The presentation of scientific papers under the several sections of the division is invited, and for participation neither membership in the association nor residence within the boundaries of the division is required. Persons desiring to present papers are requested to submit abstracts suitable for the press, not exceeding two hundred words, to the chairmen listed above so as to reach them not later than March 28.

Complete programs will be mailed to all members of the division as well as to others presenting papers. In order that these programs may be in the hands of persons contemplating attending the meeting by April 21, it is requested that the deadline of March 28 be carefully adhered to by those planning to present papers. Special requests for programs should be sent to the secretary of the division.

FRANK E. E. GERMANN,
Secretary

UNIVERSITY OF COLORADO

SPECIAL ARTICLES

STERILIZATION OF AIR BY CERTAIN GLYCOLS EMPLOYED AS AEROSOLS

THE possibility of sterilizing air by means of germicidal mists or aerosols was reported in 1938 by Trillat,[1] who has been investigating this subject for a number of years. Two groups of workers in England, Pulvertaft and Walker[2] and Twort, Baker, Finn and Powell[3] have since confirmed and extended Trillat's findings. Liquid aerosols consist of droplets of approximately 1-2 μ in diameter dispersed in the air. Larger particles tend to settle out quickly. The theoretical basis for the high bactericidal activity of germicidal aerosols is, briefly, as follows: a very small quantity of a germicidal agent may be dispersed throughout a relatively large enclosed air space, yet, *because each droplet of the aerosol contains the same concentration of the effective chemical substance as does the parent solution,* the bactericidal agent is enabled to act in high concentration on bacteria suspended in air. The actual amounts of the compound in the atmosphere may be of the order of one part by weight of aerosol to many million volumes of air.

The germicidal agents found to be most effective by the English workers were resorcinol and hexyl resorcinol. They have made tests on the oral toxicity of these compounds for animals, and find that in the amounts employed for air sterilization they are harmless for the animal body. However, both these substances possess a certain degree of toxicity, and insufficient data are available on local or systemic effects of breathing resorcinols over very long periods of time.

We became interested in the possibility of using as germicidal aerosols compounds with marked wetting and spreading properties such as the anti-bacterial detergents described by Miller and Baker.[4] Preliminary experiments indicated limited aerosol activity of aqueous solutions of such compounds. When the water was replaced by a hygroscopic vehicle such as propylene glycol, the aerosol activity was markedly increased. We found subsequently that propylene glycol and related glycols themselves acted as effective bactericidal aerosols.[5] Because of the extremely low toxicity of propylene glycol,[6] and the advantage of employing a simple aerosol, consisting of only one compound, we have conducted most of our experiments with propylene glycol and a few very closely related substances, *e.g.,* trimethylene glycol and ethylene glycol.

The technique in our experiments was as follows: known quantities of a bacterial suspension were sprayed into a rectangular glass-walled chamber, of 60 liters cubic capacity. The air was gently agitated by means of a slowly rotating rubber-bladed fan. The number of viable bacteria recoverable from the chamber air was determined by withdrawing a measured volume of air at a constant rate through a glass funnel which was suspended directly above the surface of an agar plate within a sealed glass jar.[7] By this means a relatively uniform number of colonies was obtained following the introduction into the chamber of the same amount of standardized bacterial suspension. There is a progressive and quite constant diminution in the number of colonies recovered from successive air samples taken during the period of an hour. For this reason, two identical chambers were used for each experiment, one for the test and the other for the control. The germicidal aerosol was introduced into the chamber by means of a Graeser atomizer[8] which produces a mist sufficiently fine to act as an effective aerosol. The bacterial suspensions were usually sprayed into the chamber with this type of atomizer, although other atomizers producing coarser droplets were used in some experiments.

For experiments on the general principles of the method, *Staphylococcus albus* was employed as the test microorganism. It was found that one part by weight of propylene glycol in two million volumes of air, effected complete sterilization of an atmosphere containing as many as 200,000 bacteria per cubic liter of air. Furthermore, this action occurred with surprising rapidity. Air samples taken within a few seconds after the introduction of the aerosol yielded sterile plates, while similar plates from the control chamber

TABLE I

THE EFFECT OF PROPYLENE GLYCOL AEROSOL ON STAPHYLOCOCCUS ALBUS

Time intervals of air samples	Number of colonies on plates from	
	Control chamber	Aerosol chamber
(1) Immediately after bacterial spray	2207	1860
(2) Immediately after H_2O in control and aerosol in test	764	1
(3) 15 minutes later	532	0
(4) 30 minutes later	336	0

[1] A. Trillat, *Bull. de L'Acad. de Med.,* 3 Serie, 119, 64, 1938.

[2] R. S. V. Pulvertaft and J. W. Walker, *Jour. Hygiene,* 39: 696, 1939.

[3] C. C. Twort, A. H. Baker, S. R. Finn and E. O. Powell, *Jour. Hygiene,* 40: 253, 1940.

[4] B. F. Miller and Z. Baker, SCIENCE, 91: 624, 1940.

[5] The English workers used glycols and glycerine as vehicles. However, as far as we can determine, they ascribed no importance to these compounds beyond their usefulness as hygroscopic solvents for the germicidal substances, resorcinol and hexyl resorcinol.

[6] P. S. Hanzlik, H. W. Newman, W. Van Winkle, A. J. Lehman and N. K. Kennedy, *Jour. Pharm. and Exp. Therapeut.,* 67: 101, 1939.

[7] This is a modification of the technique of air sampling described by Hollaender and Dallavalle. Public Health Reports, 54: 574, 1939.

[8] J. B. Graeser and A. H. Rowe, *Jour. Allergy,* 6: 415, 1935.

showed many hundreds of colonies. A protocol of this type of experiment is shown in Table I. Other microorganisms were found to be similarly susceptible to the action of this aerosol. Among those tested were pathogenic invaders of the respiratory tract, *e.g.*, pneumococci Type I and III, hemolytic streptococci and hemolytic staphylococci, as well as organisms of lesser or no pathogenicity, such as *Streptococcus viridans, B. coli* and *Micrococcus catarrhalis.* Bacteria sprayed into a chamber containing the germicidal mist were killed with equal rapidity.

Tests made with other glycols showed that ethylene glycol and trimethylene glycol were about as effective germicidal aerosols as propylene glycol. Glycerine, on the other hand, exhibited only slight killing action.

To prove that condensation of the glycol itself, on the collecting plates, does not inhibit growth of the organisms by bacteriostasis, suitable controls were performed which definitely ruled out any such "plate effect." Furthermore, it is conceivable that the reaction between the germicidal aerosol particles and the bacteria might somehow change the state of suspension of the bacterial droplets and prevent their adherence to the plates. To control this possibility, another method was employed for collecting the bacteria after exposure to the aerosol: air was drawn slowly through 25–50 cc of diluted nutrient broth in a glass cylinder containing many small beads. Plated samples of this fluid, through which air from the control chamber had been bubbled, yielded large numbers of colonies, whereas similar samples of fluid exposed to the aerosol-containing air were sterile.

The presence of killed bacteria in aerosol-treated air was demonstrated by condensing on a chilled microscope slide the moisture of the air drawn from the chamber. The microorganisms were stained and identified; samples of the condensed fluid showed no growth.

We have also eliminated the possibility that microorganisms, although rendered incapable of growth on artificial media, might nevertheless retain the capacity to reproduce in a suitable host. Experiments were conducted in which virulent pneumococci Type I were treated in the chamber with the propylene glycol aerosol. The air was then drawn through sterile broth in a bead tower, and 1 cc quantities of this fluid injected into mice. These animals survived. However, when the experiment was performed with air drawn from the control chamber, all the mice died of pneumococcic infection.

The only criterion employed heretofore for the lethal action of aerosols has been failure of the exposed organisms to grow on agar-coated surfaces. We believe that the more rigid types of experimental controls described above should be employed as additional methods of evaluating the germicidal activity of aerosols.

The mechanism of the aerosol action, the physical properties of the germicidal mists, the time duration of their effective action,[9] minimum effective concentration, activity of other compounds, etc., are at present under investigation. We are also observing the effect on the lungs and other body organs of animals breathing aerosol-containing atmospheres for extended periods of time.

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RACEMIZATION OF GLUTAMIC ACID WITH ALKALIES

FISCHER, Kropp and Stahlschmitt[1] racemized 1(+)glutamic acid by heating it in barium hydroxide solution in an autoclave at 160–170° for 9 hours. We have found that a barium hydroxide solution of 1(+) glutamic acid becomes optically inactive in about 88 hours when it is heated in an ordinary bacteriological autoclave at 120°.

25 g of 1(+)glutamic acid and 105 g of $Ba(OH)_2 \cdot 8H_2O$ were mixed with 500 cc of water. This mixture was heated intermittently in the autoclave. At intervals samples were removed, cooled to room temperature and filtered. 15 cc of the clear filtrate were mixed with 4 cc of concentrated hydrochloric acid, and the resulting solution was read in the polarimeter. The results obtained are plotted in the accompanying figure.

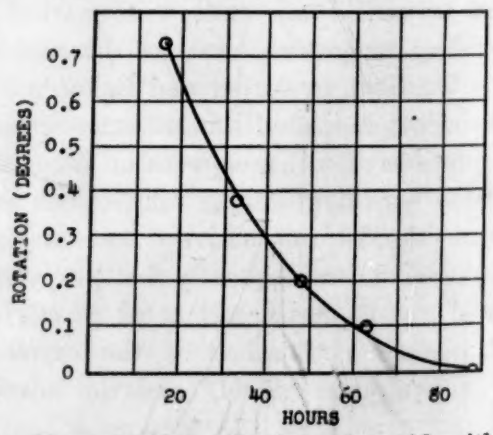

FIG. 1. Racemization of glutamic acid with barium hydroxide.

Town[2] mentioned using a sample of d,1-glutamic

[9] The germicidal action of the propylene glycol aerosol appears to be of brief duration. However, it has been found recently that the bactericidal effect may be prolonged for at least 90 minutes by the addition of a small quantity of glycerin.

[1] E. Fischer, W. Kropp and A. Stahlschmitt, *Ann. d. Chem.*, 365: 181, 1909.

[2] B. W. Town, *Nature*, 145: 312, 1940.

acid prepared by prolonged boiling of 1(+)glutamic acid in sodium hydroxide solution. We found that samples of 1(+)glutamic acid slowly racemized when they were boiled in 8 *N* and 4 *N* sodium hydroxide solutions. However, the yields obtained were very low. Ammonia was evolved continuously during the procedure, and it is evident that a considerable destruction of glutamic acid occurred.

It is our opinion that d,1-glutamic acid can be prepared most conveniently by racemization with heat.[3]

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COCHLEAR POTENTIALS FROM THE BAT

RECENT evidence[1, 2] indicates that bats locate objects in the space through which they are about to fly by hearing echoes of supersonic cries they emit. Normal flying bats produce supersonic cries having a duration of about 20 msec. in which frequencies near 50,000 cycles are most intense, and there is an increase in rate of emission as the animal approaches obstacles which will be successfully avoided. Bats rendered temporarily deaf and bats which are prevented from emitting the cry blunder into obstacles as if with no knowledge whatever of their existence.

These experiments can be explained only if it be assumed that bats hear sounds of 50 kc. In an attempt to test this assumption, cochlear potentials have been recorded from more than 30 bats of 5 different species with the results described below.

The bat cochlea produces electrical oscillations having the same frequency as the incident sound for frequencies up to 98,000 cycles. The 98 kc upper limit represents the limit of the recording apparatus, not of the cochlea. Appropriate checks establish the cochlea itself as the source of the potentials which appear in every respect to be similar to cochlear potentials from other mammals. The author, assisted by Mr. J. E. Hawkins, obtained no responses whatever above 40 kc from the cochlea of a young guinea pig tested in this apparatus.

The experiments were conducted in the laboratory of Dr. G. W. Pierce at Harvard, using a magnetostriction oscillator as the source of pure supersonic tones and a supersonic microvoltmeter to record potentials arising in the cochlea. Similar results can be obtained with a galton whistle or the cry of another bat as the source of supersonic sounds.

Although it is generally agreed that cochlear potentials per se do not necessarily indicate hearing, these experiments are taken to support the theory that bats locate obstacles by hearing echoes of their supersonic cries. Further details of the response of the bat ear will be presented in a report now in preparation.

The author is indebted to Drs. G. W. Pierce, Hallowell Davis and A. C. Redfield for the use of their laboratories and for their generous criticisms and suggestions.

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SCIENTIFIC APPARATUS AND LABORATORY METHODS

PHOTOELECTRIC TEMPERATURE CONTROL

A SYSTEM of control for a constant temperature bath employing a thyratron tube has been described by Schmitt and Schmitt.[1] The thyratron is a grid-controlled mercury vapor rectifier of considerable current carrying capacity. In their apparatus the tube served as an on-and-off relay, the grid potential being raised and lowered by the make-and-break of a toluene-mercury thermoregulator. Increased accuracy of temperature control, as compared with the usual electromagnetic relay system, was obtained as a result of the small current flow in the grid circuit and consequent avoidance of fouling of the mercury surface.

In the system which I shall describe, the advantages of the thyratron tube are more fully exploited by employing the phase-shift method of control and by eliminating the make-and-break contact altogether. The method makes possible the construction of a very accurate and reliable constant temperature bath at very modest cost.

A toluene-mercury thermoregulator is used which is so constructed that the column of mercury interrupts a beam of light concentrated to a point by means of a lens. This part of the apparatus is shown diagrammatically in Fig. 1. The light which passes through the capillary above the mercury strikes the cathode of a phototube. Rise or fall of the mercury

[3] L. E. Arnow and J. C. Opsahl, *Jour. Biol. Chem.*, 134: 649, 1940.

[1] D. R. Griffin and R. Galambos, paper read at the American Association for the Advancement of Science meetings in Philadelphia, Pa., January, 1941. Abstract in *Anat. Rec.*, 78: 95. 1940. Supplement.

[2] R. Galambos and D. R. Griffin, paper read at the American Association for the Advancement of Science meetings in Philadelphia, Pa., January, 1941. Abstract in *Anat. Rec.*, 78: 95. 1940. Supplement.

[1] F. O. Schmitt and O. H. A. Schmitt, SCIENCE, 73: 289, 1931.

column decreases or increases the amount of light falling on the phototube, and this in turn, through the electrical circuit described below, controls the amount of current flowing through the heating unit.

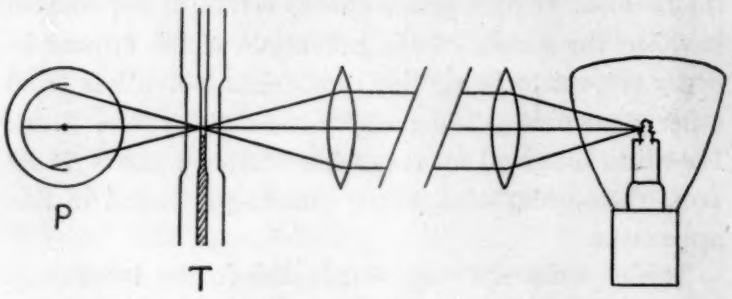

FIG. 1. P—phototube, T—upper part of thermoregulator.

The electrical circuit is shown in Fig. 2. It was taken from Nottingham[2] and is essentially the same as the scheme given by Hull[3] for photoelectric control of a thyratron by the phase-shift method. The circuit was not applied by these authors to temperature control, however. T is the thyratron tube, General Electric Type FG-57, P is the phototube, Type PJ-23,

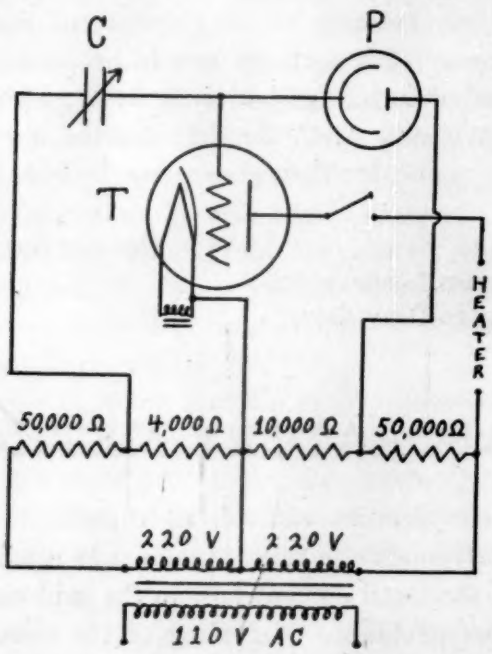

FIG. 2

and C is a variable condenser of 100μμf capacity. It will be seen that alternating voltage is applied to the grid. When this voltage is in phase with the anode voltage the maximum current will flow in the anode circuit. But as the grid voltage is gradually retarded in phase through 180°, the average anode current decreases continuously to zero. This phase shift in the grid voltage is brought about by increase in the resistance of the phototube resulting from decrease in the intensity of light falling upon it.

Thus the heater operates continuously, with very little variation, at a level just sufficient to balance the loss of heat through the walls of the water bath. This continuous control of heat input has the advantage of reducing periodic fluctuations in temperature to an almost infinitesimal value, but it carries with it a potential source of error in that changes in the ambient temperature will be reflected, on a greatly reduced scale, in the bath temperature. However, except perhaps in cases of extreme variation in the room temperature, good insulation of the bath together with adjustments of the system making for maximum sensitivity will keep this variation within very narrow limits. In a laboratory where the room temperature does not vary widely, the bath temperature has been observed to remain constant to ± .001° C for periods of 48 hours and nearly as constant over much longer periods.

A few practical suggestions based on my experience with the apparatus may be added. As a light source a 32 candle power headlight bulb operated from a 6.3 volt transformer has proved satisfactory. The capillary of the thermoregulator (2 mm inside diameter) is compressed so that the cavity becomes a flat oval in cross section, thus minimizing spreading of the light beam as it passes through, and at the same time increasing sensitivity by decreasing the area of cross section of the capillary. The capillary is painted on the outside with black glass-marking ink, except for a slit on each side through which the beam passes. I have had the bulb of the thermoregulator made in the form of a helix, so as to combine large volume with small diameter.

The parts for constructing this apparatus, exclusive of stirrer and heater, can be purchased for about thirty dollars.

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[2] W. B. Nottingham, *Jour. Franklin Inst.*, 211: 271, 1931.

[3] A. W. Hull, *Gen. Elec. Rev.*, 32: 213 and 390, 1929.

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